USAFETAC/PR-89/002

(2)

MICROWAVE PROPAGATION STUDY

FOR THE

FLORIDA GULF COAST

by

Capt Charles ("Ted") Linn

MARCH 1989

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USAF
ENVIRONMENTAL TECHNICAL
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Scott Air Force Base, Illinois, 62225-5438

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UNCLASSIFIED

REPORT DOCUMENTATION PAGE

1a. Report Security Classification: UNCLASSIFIED

3. Distribution/Availability of Report: Approved for public release; distribution is unlimited.

4. Performing Organization Report Number: USAFETAC/PR-89/002

6a. Name of Performing Organization: USAF Environmental Technical Applications Center (USAFETAC)

6b. Office Symbol: USAFETAC/ECA

6c. Address: Scott AFB, IL 62225-5438

11. Title: Microwave Propagation Study for the Florida Gulf Coast (Unclassified)

12. Personal Author: Capt Charles Linn

13a. Type of Report: Project Report

14. Date of Report: March 1989

15. Page Count: 317

17. COSATI Codes: Field--04, Group--02

18. Subject Terms: CLIMATOLOGY, WEATHER, ATMOSPHERIC REFRACTION, SUPERREFRACTION, SUBREFRACTION, REFRACTIVITY, MICROWAVE COMMUNICATIONS, RAY TRACING, FLORIDA.

19. Abstract: Documents a 1980 USAFETAC study of atmospheric refractivity and its effects on microwave communications along the Gulf coast of Florida. The study involved 11 selected cases of both "good" and "bad" received signal levels (RSLs). The database incorporated weather sounding data from tethered balloons at Cape San Blas, White City, and Apalachicola, as well as surface weather observations from Apalachicola, Tyndall AFB, and Eglin AFB. Each case includes examples of RSL strip charts, synoptic-scale weather maps, tables of surface observations, M-profile plots, and raytrace plots. General conclusions and suggested ways to solve propagation problems are included. Keywords: Microwave communications; Atmospheric refraction (KR)

20. Distribution/Availability of Abstract: Same as report.

21. Abstract Security Classification: UNCLASSIFIED

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22c. Office Symbol: USAFETAC/ECA

UNCLASSIFIED

PREFACE

This study documented here (USAFETAC Project 1879) was originally completed by USAFETAC/ENA (now ECA) in 1980 as an interim, unpublished report to the 1842 Electronics Engineering Group (AFCC) at Scott AFB, IL. It answered the 1842 EEG's request for data that would help them upgrade a microwave link used to control F-102 drones at Tyndall AFB, FL. For various reasons, a final report was not prepared, and intentions to publish the report went unfulfilled. Recent requests for copies of the original report, however, suggest that the data is of sufficient value and interest to warrant publication. The report, therefore, has been reevaluated and approved for publication by USAFETAC's Systems Support Section of the Environmental Applications Branch (USAFETAC/ECA).

Captain Charles "Ted" Linn (now an Air Weather Service civilian employee at the Air Force Operational Test and Evaluation Center) analyzed the data and wrote the original report. Mr Carl Bower (now employed by Headquarters Air Force System Command) edited and approved it. Sergeant Tanya Serkin (now a school teacher in St Louis, MO) processed the data and prepared the ray traces.

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INTRODUCTION

1. This abbreviated report documents work done on USAFETAC Project 1879 for the 1842 EEG at Scott AFB, IL. It was originally titled "Microwave Propagation for Drones." The report is "abbreviated" in the sense that only the most urgent needs of the 1842 EEG were considered in its preparation. Results of the entire project, including other analyses and details on data collection, processing, and formatting, were intended to be published later. For a variety of reasons, however, the report remained unpublished until now, after its contents were shown to be valuable to several users, and after thorough reevaluation by USAFETAC/ECA.

2. Project 1879 tasked USAFETAC to examine selected weather data (some routinely available in the USAFETAC database and some collected specifically for the project) and provide the 1842 EEG meteorological advice that would assist in upgrading a special microwave communications link near Tyndall AFB, FL. The upgrade was necessary because the link had experienced severe received signal level (RSL) fading that resulted in unacceptable communications losses in Tyndall Range operations. The upgrade requirement was to 99.9999% reliability. Weather data available in the USAFETAC database consisted mostly of surface weather observations from Apalachicola, Tyndall AFB, and Eglin AFB. Specially collected weather data consisted of more than 400 tethered balloon upper-air soundings (most from surface to about 300 meters) and a set of synoptic scale surface weather and radar observation summary charts. The period of interest was from 19 October 1978 through 13 December 1978. Tethered balloon data was collected at Cape San Blas, White City, and Apalachicola, all in Florida. Figure I-1 and Table I-1 depict the more important variables associated with the microwave link and the special tethered balloon sites. The 1842 EEG collected noncontinuous RSL data from the microwave link during the entire period of interest. Data was recorded on magnetic tape and on strip charts, but seldom simultaneously. Frequencies for all channels on the links were between 7 and 8 GHz.

3. From the weather and RSL data, the 1842 EEG and USAFETAC selected 11 case periods for analysis. Cases 1 through 7 involved periods of erratic RSL fluctuations ("bad" periods), and cases 8 through 11 involved periods of relatively stable RSL readings ("good" periods). The case study approach was required since no single data set was continuous or synchronous enough with any other (weather or RSL) to permit execution of statistical correlation programs. Table I-2 lists the cases studied by number, time period, RSL condition, and path. *NOTE:* The section covering Case 1 contains important information on the raytrace output and the validity of the assumptions used; it should be read first. Much briefer descriptions of the data are then given for Cases 2 through 11.

4. Considerable time was spent reducing raw tethered balloon data into usable form. Once that was accomplished, graphic plots of height versus modified refractive moduli (M-units) were prepared. M-units were calculated from standard refractive moduli (N-units), using the following formula:

$$M = N + 0.157h \tag{1}$$

where h is the height of N in meters. N-units were calculated from the Smith-Weintraub formula:

$$N = 77.6(P/T) + (3.73 \times 10^5)(e/T^2) \tag{2}$$

where P = pressure in millibars, e = vapor pressure in millibars, and T = temperature Kelvin. Raytrace plots (which depict--at least in a very qualitative sense--microwave propagation patterns from M-unit profiles) were also prepared. Appendix A describes the raytrace plots.

5. Vertical gradients of M, normalized to M per kilometer, served as input to the raytrace program. These normalized gradients relate to the standard categories of atmospheric refraction as follows:

M-gradient $\leq$ 0 = Trapping   0 < M-gradient $\leq$ 79 = Superrefraction.

79 < M-gradient $\leq$ 157 = Normal Refraction   M-gradient > 157 = Subrefraction

6. Each case examined includes examples of RSL strip charts, synoptic scale surface weather maps, tables of surface weather observations, M-profile plots, and raytrace plots. Figure I-2 shows the weather symbols and descriptions used in the surface synoptic weather charts. The following abbreviations are used in the surface weather observation tables:

ABBREVIATION	DESCRIPTION
OVC	Overcast Sky
BKN	Broken Clouds (ceiling exists)
SCT	Scattered Clouds (no ceiling exists)
CLR	Clear Sky
F	Fog
GF	Ground Fog
K	Smoke
H	Haze
TRW	Thunderstorm*
RW	Rainshower*
R	Rain*
--	Observation missing/not reported

* if followed by "-," *light*; if "+," *heavy*.

7. The geometries of the two links studied are shown in Figures I-4 and I-5. These figures show the heights of the antennas and tower bases in meters above mean sea level (MSL), the half-power vertical beam width ranges in milliradians (corresponds to 1.2 degrees), and the great circle range of each link. These values were used in preparing the raytrace plots.

8. Although time limitations prevented extensive analysis of the data, it was possible to arrive at some general conclusions about the meteorological conditions and possible ways to overcome them; these are discussed in "Conclusions" on page 294. Several limitations and assumptions about the data and the computations, however, require explanation:

a. Corrected heights in the sounding data were measured by the length of tether spooled out in 5-meter increments. Corrected heights, required because of tilts in the tethered balloon trajectory, were computed by using only the reported elevations angle of the balloon at the top of the sounding and a simple trigonometric equation (see Figure I-3).

b. Pressures in the tethered balloon sounding data for each level were computed from the equation of state and the hydrostatic equation by computing a mean temperature for each approximate 5-meter increment of height and using the measured surface pressure from Apalachicola.

c. The measured temperature and relative humidity ordinate values (extracted from the sonde recorder) were filtered by using a 1-2-1 vertical smoothing technique (excluding the first two values above ground). Actual temperatures and dew-point temperatures were then computed by using special reduction equations provided by the sonde manufacturer.

d. The time for each balloon ascent was about 20-30 minutes; therefore, each vertical M-profile does not represent an instantaneous "snapshot" of refractive conditions. The date-time group of each sounding is the ascent start-time to within about 3 minutes.

e. There is no error analysis (for biased or random errors) of the sounding data. Because instrument and equipment inaccuracies and imprecisions, operator error, and computational/theoretical errors are unknown, no specific confidence levels can be assigned to the sounding data.

f. Total microwave link system calibration values were not available to USAFETAC.

g. Raytrace plots are based on a simple geometrical-optics raytrace program that assumes horizontal (or spherical) homogeneity of an M-profile throughout the 50-km range scale specified and does not consider frequency differences. Also, raytraces only indicate propagation effects based on two-dimensional (vertical) beam bending due to refraction; therefore no refraction (other than smooth surface), diffraction, forward scattering, or atmospheric attenuation effects are accounted for. In addition, each raytrace input was limited to 15 selectable vertical M-gradients.

h. The test period (19 October 1979-13 December 1979) does not represent annual climatological conditions in the area of interest; therefore, any conclusions drawn probably have a bias in favor of the test period.

i. Data and time limitations restricted the study to examination of only the D1C-D3 and D3-APA links in the network.

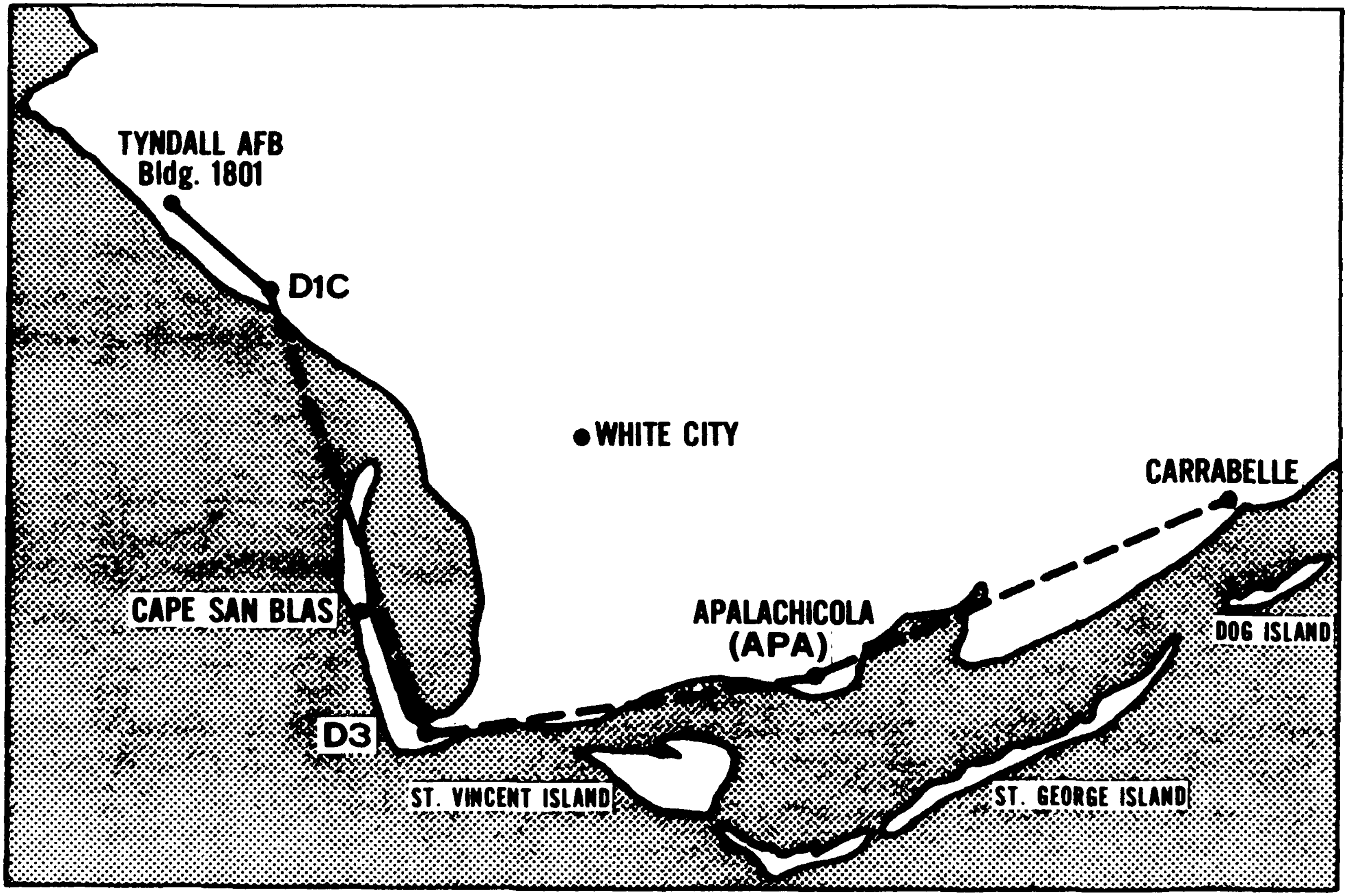


Figure I-1 Florida Gulf Coast Test Sites

Table I-1 Tethered Balloon Site Parameters

Parameter	White City	Cape San Blas	Apalachicola
Latitude	29° 53' N	29° 44' N	29° 44' N
Longitude	85° 14' W	85° 23' W	85° 02' W
Elevation (MSL)	0 m	0 m	5 m
Standard Time	EST	EST	EST
Date First OB	78 10 28 10Z*	78 10 19 00Z	78 11 04 10Z
Date Last OB	78 11 07 08Z	78 11 26 13Z	78 12 13 17Z
No. OBS	30	159	225
Average Time for OB Ascent	20-30 min	20-30 min	20-30 min

* Z denotes Greenwich Mean Time

SYNOPTIC WEATHER MAP SYMBOLS

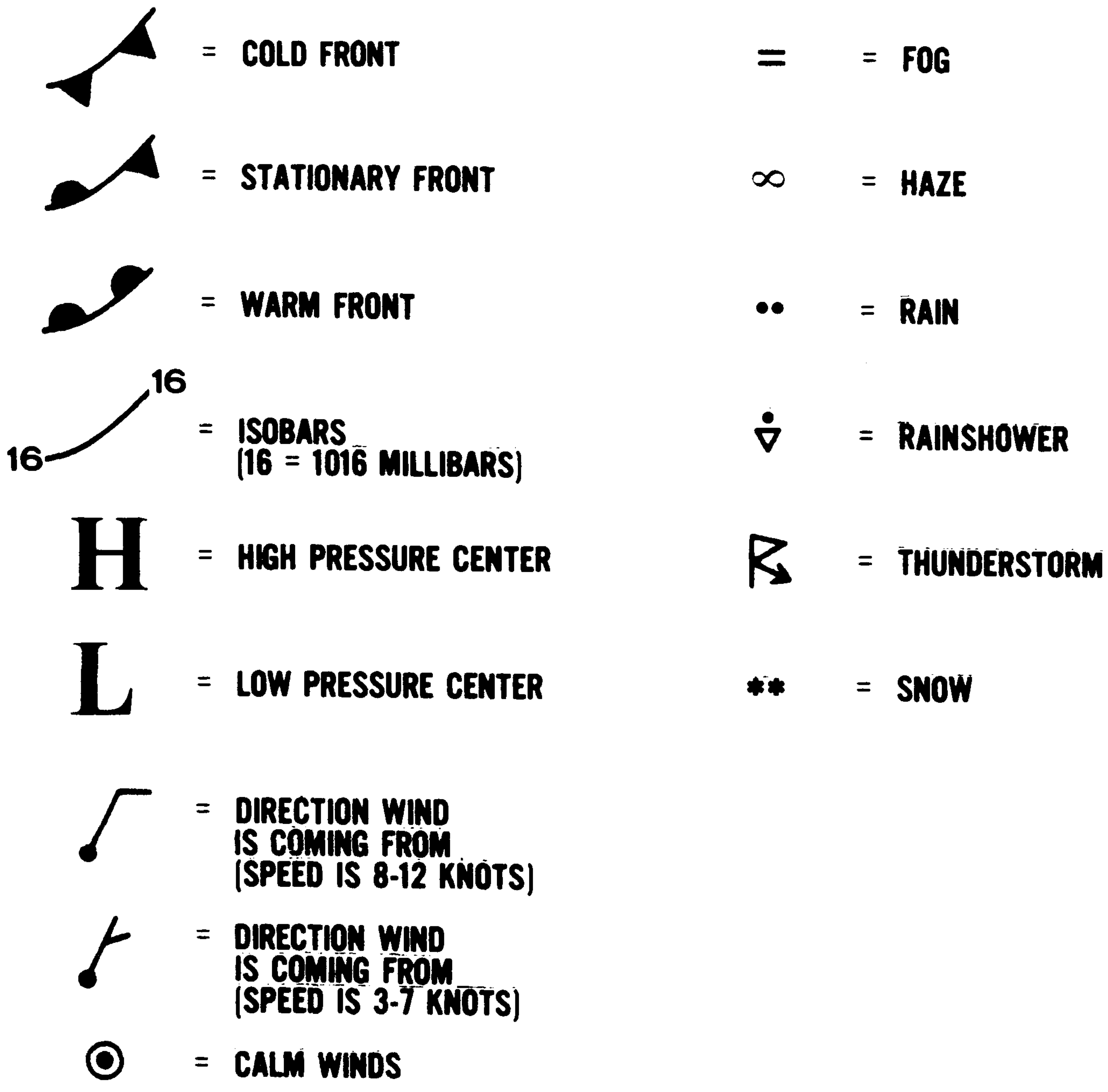


Figure I-2 Synoptic Weather Map Symbols

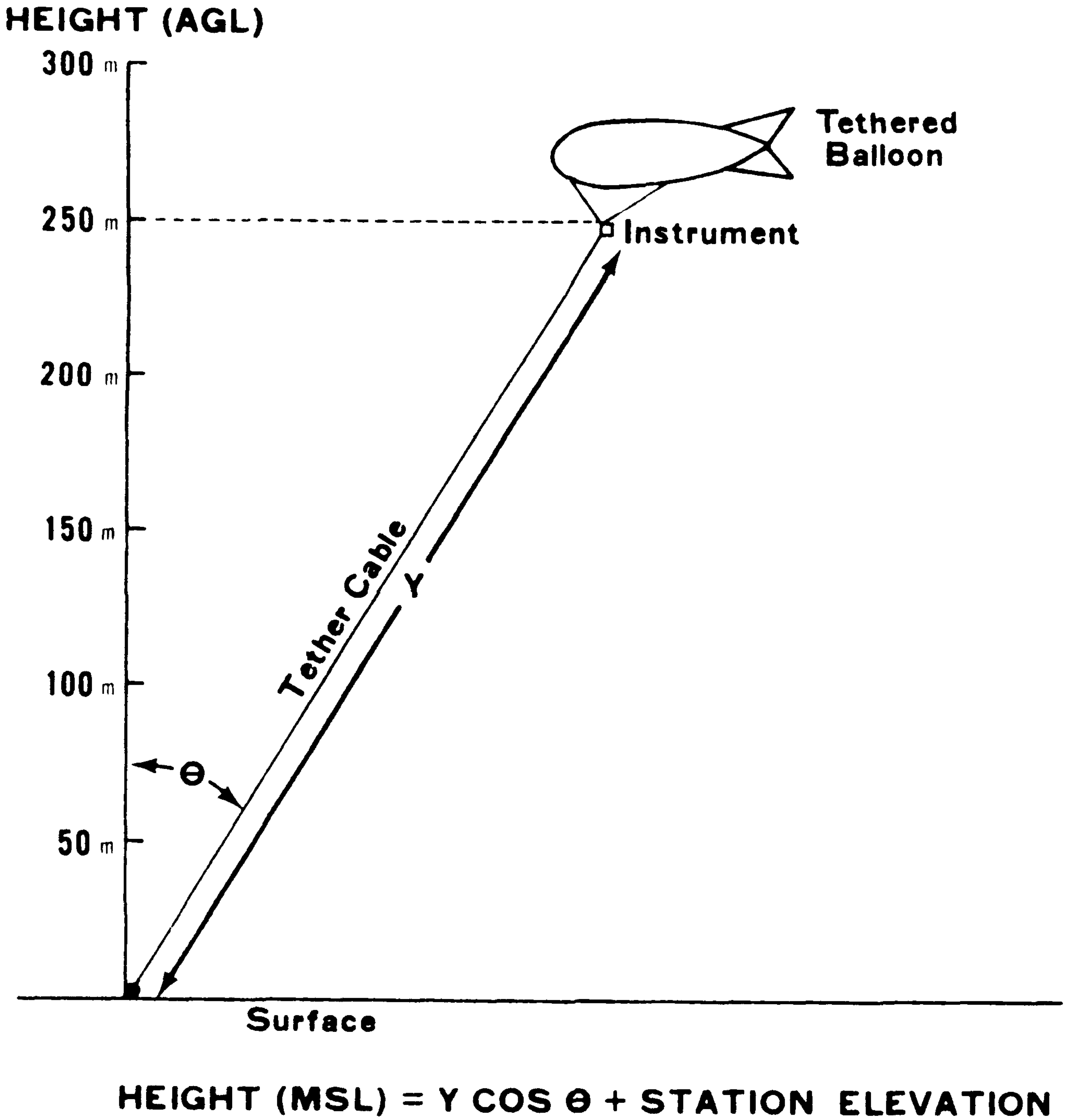
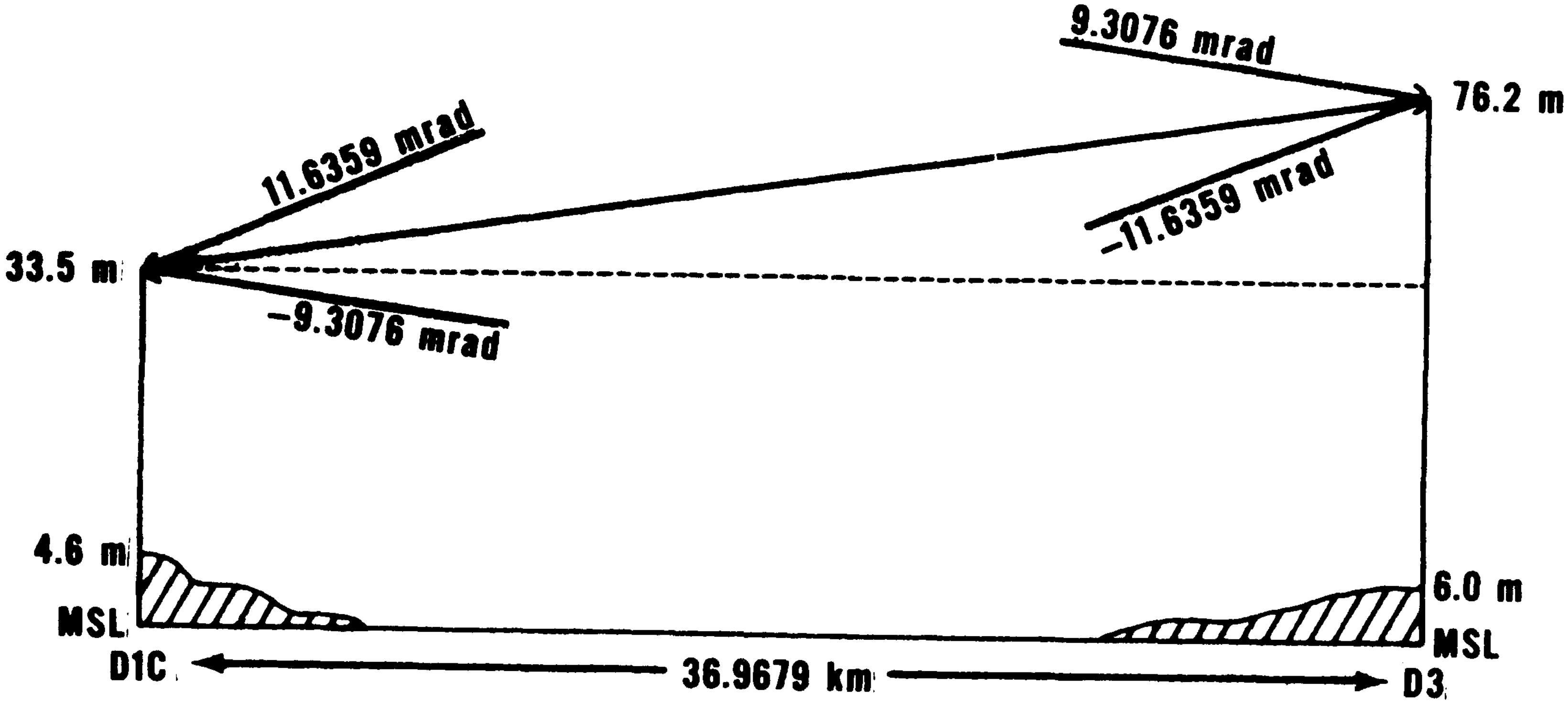
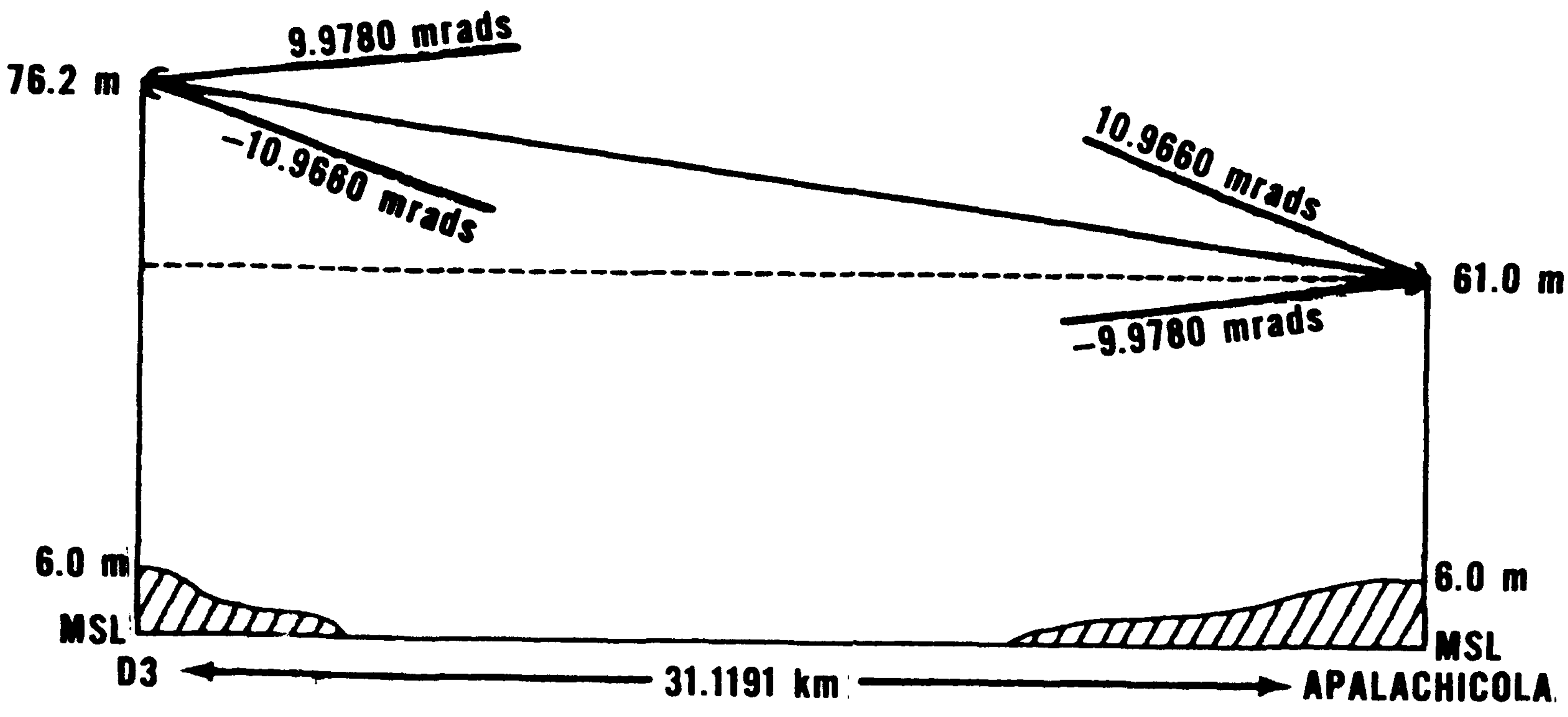


Figure I-3 Tethered Balloon Configuration



D1C — D3 LINK

Figure I-4 D1C - D3 Link



D3 — APALACHICOLA LINK

Figure I-5 Apalachicola Link

Table I-2 Summary of Case Periods, RSL Conditions and Paths

Case	1978 Case Period (LST)*	Case Period (Z)*	RSL Condition	Path
1	31 Oct/13 - 01 Nov/09 CST	31 Oct/19 - 01 Nov/15Z	Fade	D3 → D1C
2	02 Nov/20 - 03 Nov/12 CST	03 Nov/02 - 03 Nov/18Z	Fade	D3 → D1C
3	03 Nov/23 - 04 Nov/11 CST	04 Nov/05 - 04 Nov/17Z	Fade	D3 → D1C
4	05 Nov/00 - 05 Nov/13 EST	05 Nov/05 - 05 Nov/18Z	Fade	D1C → D3
5	12 Nov/04 - 12 Nov/10 EST	12 Nov/09 - 12 Nov/15Z	Fade	D3 → APA
6	16 Nov/00 - 16 Nov/05 EST	16 Nov/05 - 16 Nov/10Z	Fade	APA ↔ D3
7	22 Nov/20 - 23 Nov/06 EST	23 Nov/01 - 23 Nov/11Z	Fade	D3 → APA
8	30 Oct/18 - 31 Oct/14 CST	31 Oct/00 - 31 Oct/20Z	Good	D1C → D3
9	06 Nov/05 - 07 Nov/13 CST	06 Nov/11 - 07 Nov/19Z	Good	D1C → D3
10	16 Nov/05 - 18 Nov/22 EST	16 Nov/10 - 19 Nov/03Z	Good	D3 → APA
11	19 Nov/06 - 22 Nov/20 EST	19 Nov/11 - 23 Nov/01Z	Good	D3 → APA

* Most data are presented in terms of Greenwich Mean Time (GMT or Z); however some data are presented in terms of local standard time (LST) - either Eastern Standard Time (EST) or Central Standard Time (CST). Conversions are (1) for EST, add 5 hours to get Z, and (2) for CST add 6 hours to get Z.

CASE 1

1. This case period (from 1900Z 31 October to 1500Z 1 November was defined by the 1842 EEG to be characteristic of RSL fading conditions on the D1C-received signal from the D3 transmitter. Figures 1-1 and 1-2 are typical of RSL recordings obtained during the period. The computed free-space signal level for this path (both directions and both channels) was -36 dbm, while the computed FM-threshold (level at which signal modulation is lost) was -80 dbm. Although the 1842 EEG indicated that the patterns strongly suggest multipath fading, interpretation of the type of fade indicated in the strip chart patterns is best left to experienced communications engineers.

2. The synoptic weather pattern for Case 1 is shown by the weather maps in Figures 1-3 through 1-5. Most of the period was typified by a relatively weak pressure gradient (i.e., wide spacing between pressure contours), light surface winds from the northeast, and no precipitation within radar range of Apalachicola. Early morning fog was widespread throughout the region.

3. Surface weather observations from Apalachicola, Tyndall AFB, and Eglin AFB, for every 3 hours during the period are listed in Tables 1-1 through 1-3. Particularly noteworthy is the general stability (very few clouds, light northeasterly winds, and the ground-fog formation at Apalachicola during early morning).

4. Figures 1-6 through 1-8 show vertical profiles of computed M-units from tethered balloon observations taken during the period. For this case, six soundings were available from Cape San Blas, three from White City. All Cape San Blas profiles except the 1 Nov/16Z sounding showed considerable fluctuations in M from the surface to 100-150 meters. There was normal or near-normal refraction from 150 to 300 meters. White City profiles did not show quite as much fluctuation in M, but normal or near-normal refraction (except for the 1 Nov/16Z sounding) did not occur in the first 100-150 meters. Most of these fluctuations in M probably represent microscale variations in atmospheric density caused by moisture and temperature inhomogeneities associated with air-sea-land interactions in the boundary layer (the very low region of the atmosphere, strongly influenced by local terrain conditions). These air-sea-land interactions are very localized and depend on many factors such as low-level wind direction/speed, air-sea-land temperature, moisture availability, and solar radiation levels (or lack thereof). Furthermore, they can vary significantly with a single coastal microwave path, such as D1C-D3.

5. Figure 1-9 shows a standard atmospheric raytrace. Figures 1-10 through 1-36 show raytraces for all M-profiles available with the case period that extended to heights of at least 200 meters. Vertical and horizontal scales in all raytraces for this and all other cases are 200 meters and 50 kilometers, respectively. Since the raytrace program required input M-gradients to extend as high as the vertical scale used, no M-profiles that terminated below 200 meters were used for raytracing analysis. All raytraces show 0.2-milliradian (1 degree = 17.453 milliradians) spacing between rays; since the family of rays constitute about 20 milliradians of vertical beam width, there are about 100 rays associated with each raytrace plot.

6. For this case and most others, raytraces were prepared for each communication site's transmitting antenna height in the link being examined and for a fictitious D3 transmitting antenna at 158.4 meters MSL (500 feet AGL). Therefore, there are usually three separate raytraces for each M-profile. The numbers to the left of each raytrace (except for the standard atmosphere plot) and under the M-profile heading represent the input M-gradient values normalized to 1 kilometer. For example, if M decreased from 350 to 340 in a 20-meter height increment, the normalized gradient would be -500 M-units per kilometer and would be assigned to the height at the top of the 20-meter increment. For all raytraces, the solid lines represent direct rays and the large dashed lines represent reflected rays from perfectly smooth terrain.

7. Due to the numerous assumptions inherent in the raytrace program and the fine-scale data used as input, the individual rays almost certainly do not represent reality; therefore, only a qualitative examination of the overall ray pattern in any raytrace should be considered. For example, was the direct ray pattern in the vicinity of the receiver disrupted/lacking or was it a fairly smooth, dense family? Even conclusions based on a qualitative type of

examination should be treated with caution due to the sensitivity and multivariate nature of microwave beam propagation in the lower atmosphere (especially near coastlines).

8. For nearly all raytraces at existing antenna heights and in the receiver vicinity, some degree of direct-ray pattern disruption is evident, whereas practically no direct-ray disruption occurs when transmitting the beam from 158.4 meters. This holds true regardless of whether Cape San Blas or White City data were used. In spite of the limitations of raytracing, this suggests a possible improvement in RSL by using a high transmitting antenna (158.4 meters) and a low receiving antenna (less than 50 meters). Such apparent improvement is strictly a function of the larger incidence angles of the rays that are penetrating relatively thin, assumed horizontal refractive layers. Since these small but intense variations in M appear to have very little persistence in space or time (based on examination of all M-profiles for all data collected), the assumption of horizontal homogeneity through a 50-kilometer range almost certainly is invalid. However, from a strict geometric standpoint, persistency of M variations may be irrelevant. This means that larger incidence angles may very well still improve the true beam pattern and the RSL, provided that multipath problems due to reflections (either from the surface or from thin atmospheric "sheets") or to some complicated diffraction phenomenon, does not occur. Currently, USAFETAC has neither the capability nor the data to examine reflection and diffraction conditions in these links properly.

9. Most raytraces for this case (and the others that follow) clearly indicate pattern disruption in the vicinity of the receiver when existing transmitter heights are used. They also indicate that there is much less disruption when the D3 transmitting antenna is raised to 158.4 meters MSL.

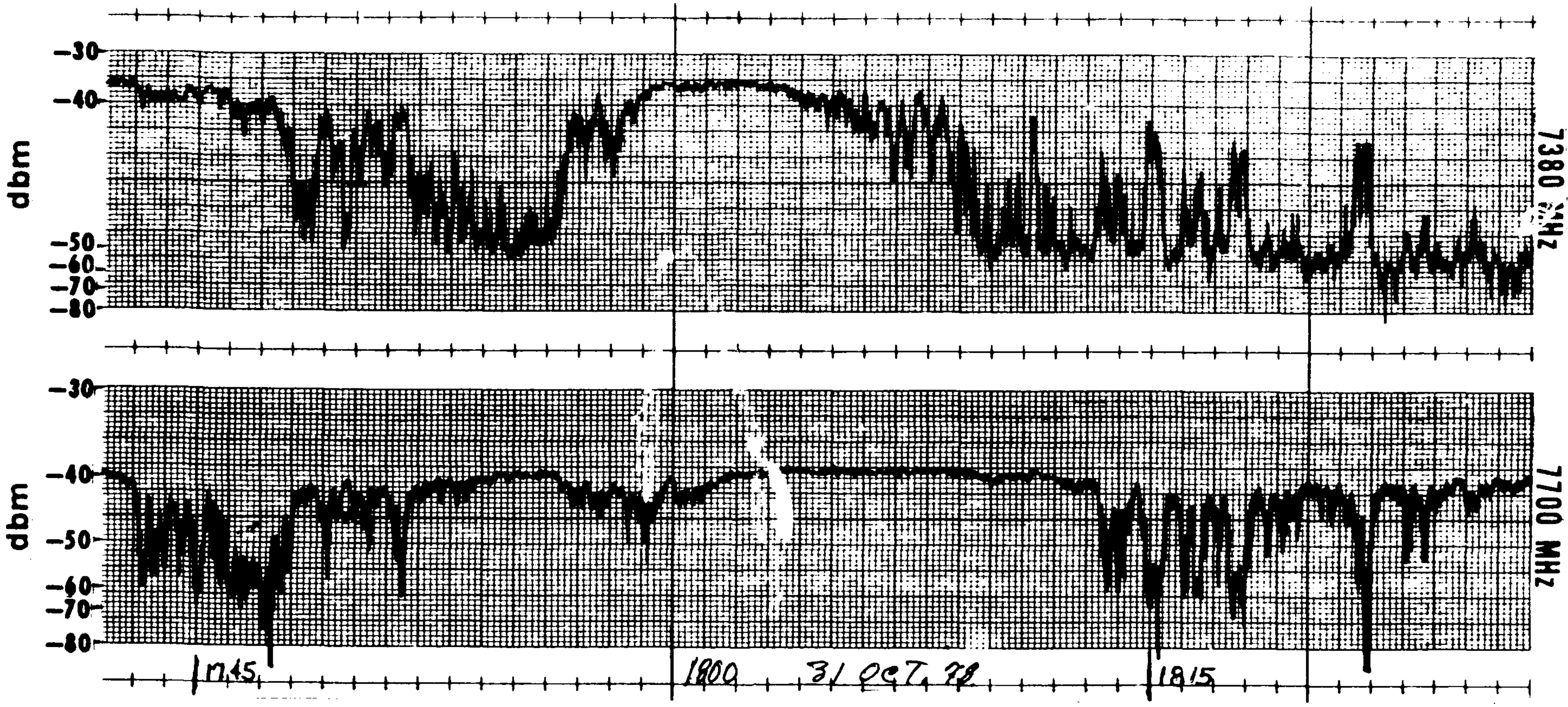


Figure 1-1 Case 1 RSL Strip Chart showing typical fade pattern on both channels of D1C received from D3. Times are from 1742 CST to 1827 CST, 31 Oct 78. The dbm calibration levels are listed to the left, and channel frequencies in MHz are listed on the right.

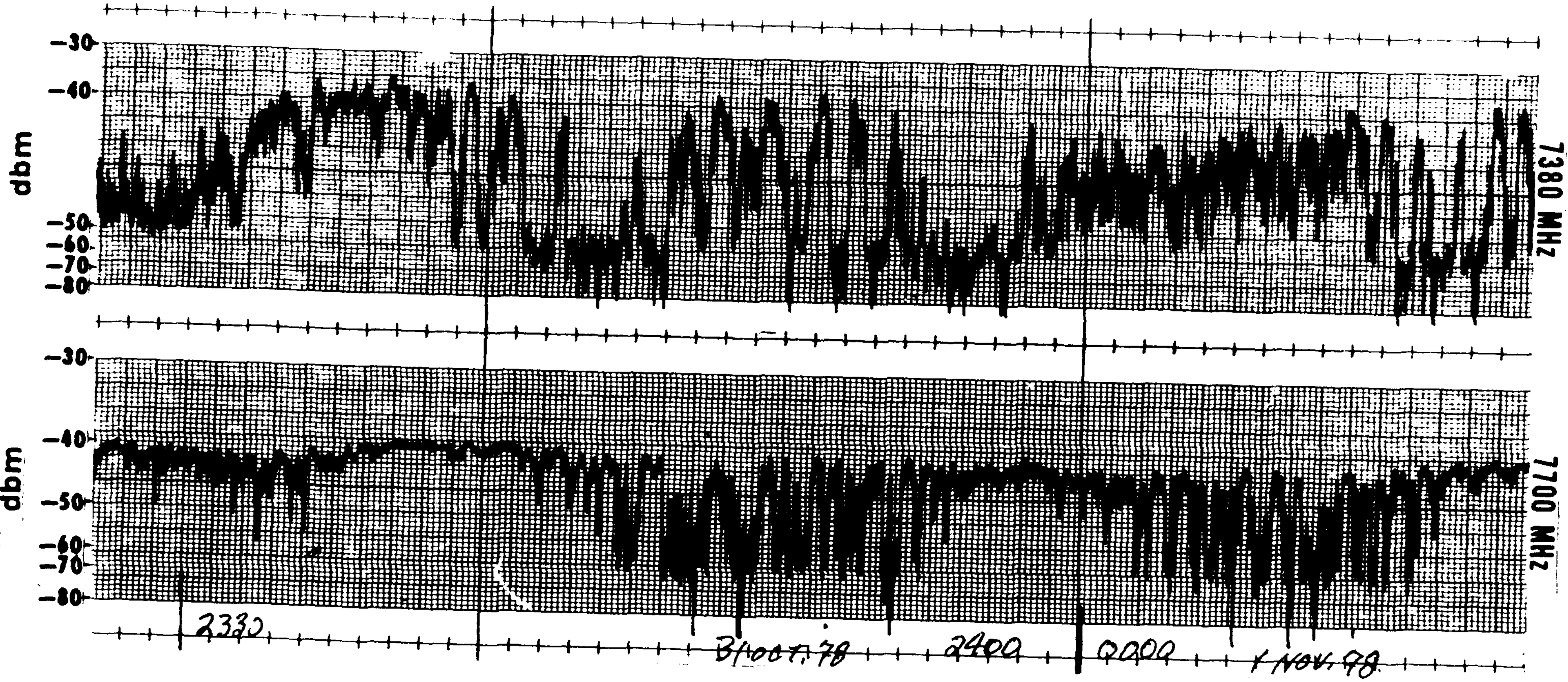


Figure 1-2 Case 1 RSL Strip Chart showing typical fade pattern on both channels of DIC received from D3. Times are from 2327 CST, 31 Oct 78 to 0015 CST, 1 Nov 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

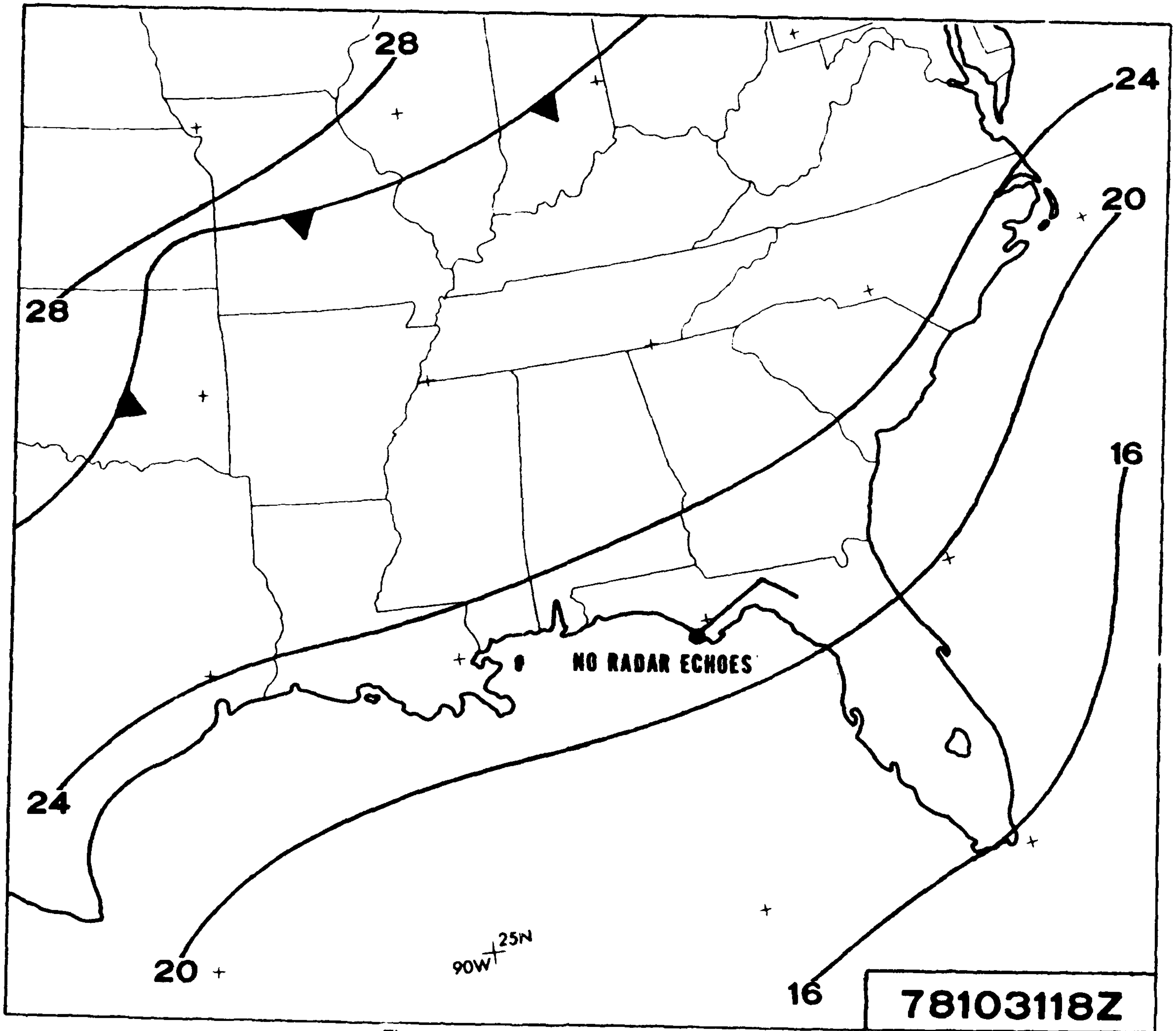


Figure 1-3 78103118Z Synoptic Chart

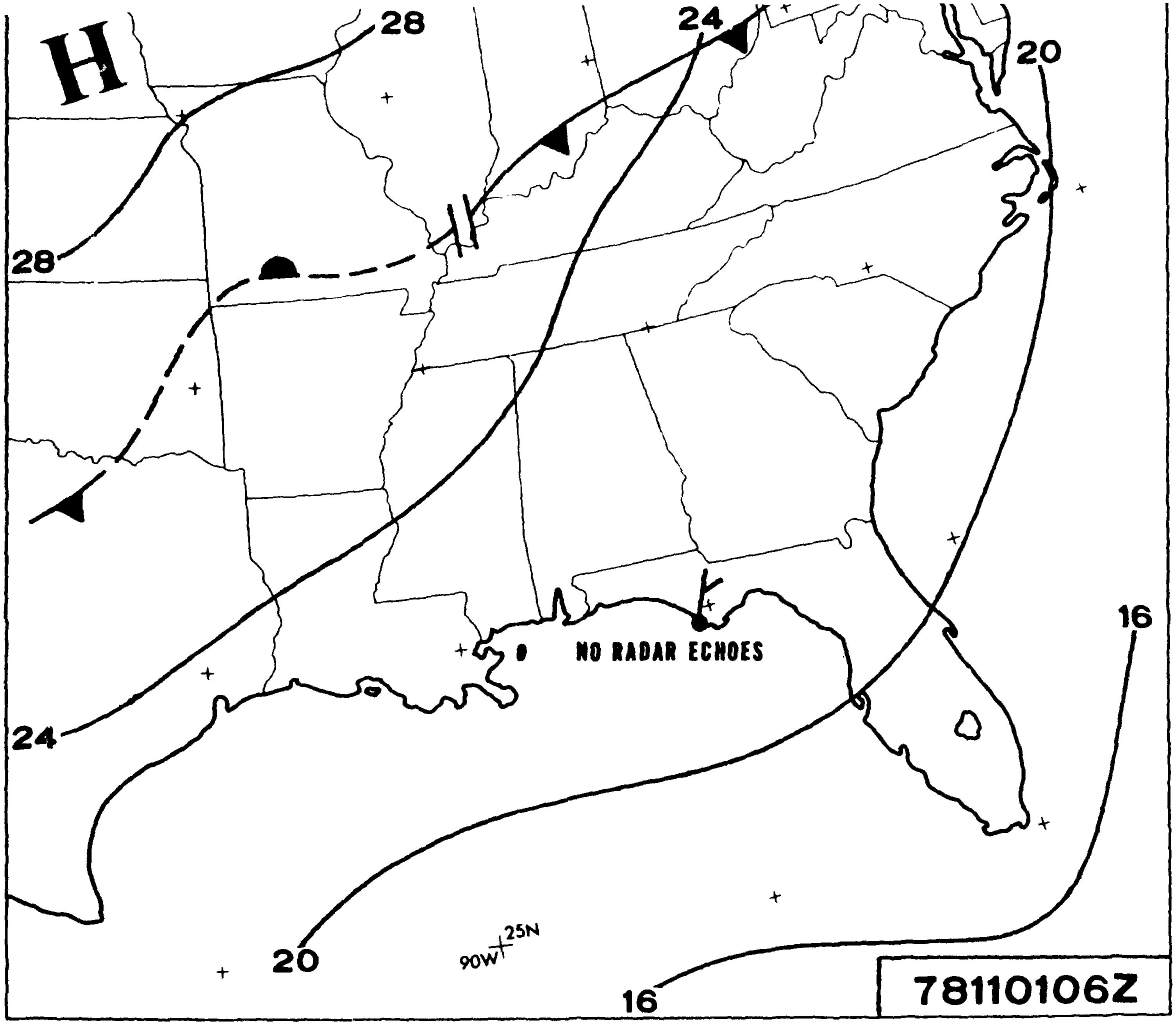


Figure 1-4 78110106Z Synoptic Chart

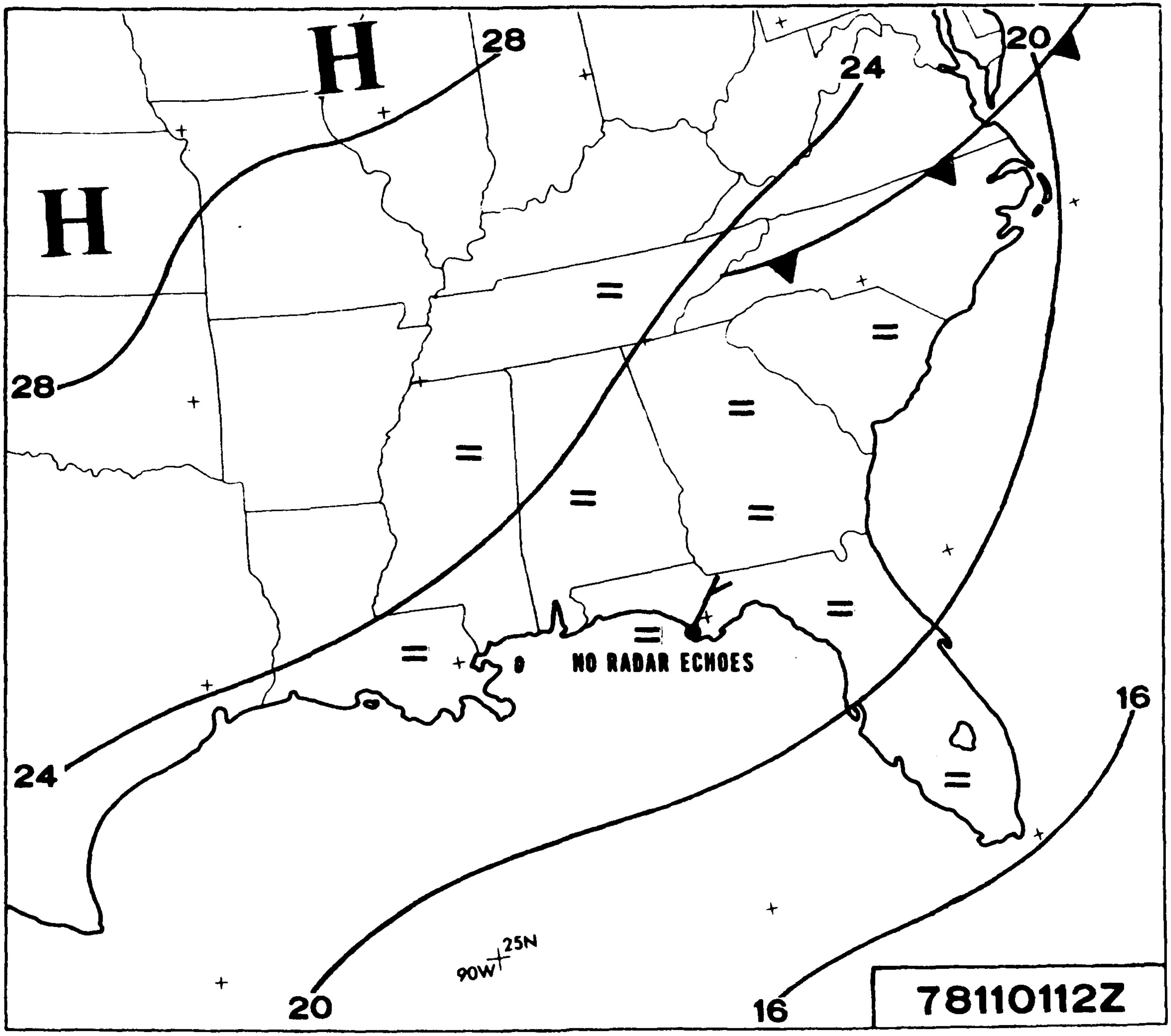


Figure 1-5 78110112Z Synoptic Chart

Table 1-1. Case 1, Apalachicola Surface Weather, 31 Oct 78, 1900Z - 01 Nov 78, 1500Z.

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
10 31 18	24.4	8.8	70	10	SCT	7	None
21	24.4	7.2	160	6	CLR	7	None
11 01 00	19.4	1.6	10	4	CLR	7	None
03	18.3	2.2	10	4	CLR	7	None
06	17.2	2.8	10	3	CLR	7	None
09	16.1	2.8	40	4	CLR	7	None
12	13.9	1.7	50	3	CLR	6	GF
15	22.2	6.1	60	5	CLR	7	None
18	26.1	15.0	50	7	CLR	7	None

Table 1-2. Case 1, Tyndall Surface Weather, 31 Oct 78, 1900Z - 01 Nov 78, 1500Z.

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
10 31 18	25.0	11.7	20	6	BKN	7	None
21	26.7	12.8	10	7	BKN	7	None
11 01 00	22.2	8.3	20	2	SCT	7	None
03	20.6	7.8	30	4	CLR	7	None
06	18.9	6.7	CALM	CALM	CLR	10	None
09	16.7	5.0	30	3	CLR	7	None
12	16.7	5.0	30	2	SCT	7	None
15	22.2	10.5	80	4	CLR	10	None
18	27.2	16.6	20	7	CLR	10	None

Table 1-3. Case 1, Eglin Surface Weather, 31 Oct 78, 1900Z - 01 Nov 78, 1500Z.

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
10 31 18	31.7	16.7	50	7	OVC	8	None
21	27.2	12.1	20	5	BKN	10	None
11 01 00	23.9	9.5	360	2	SCT	10	None
03	20.6	6.2	CALM	CALM	CLR	10	None
06	18.3	4.4	360	2	CLR	10	None
09	17.2	3.9	360	2	CLR	10	None
12	15.0	2.2	350	2	SCT	10	None
15	22.8	9.5	20	5	CLR	8	None
18	26.7	13.9	30	8	SCT	8	None

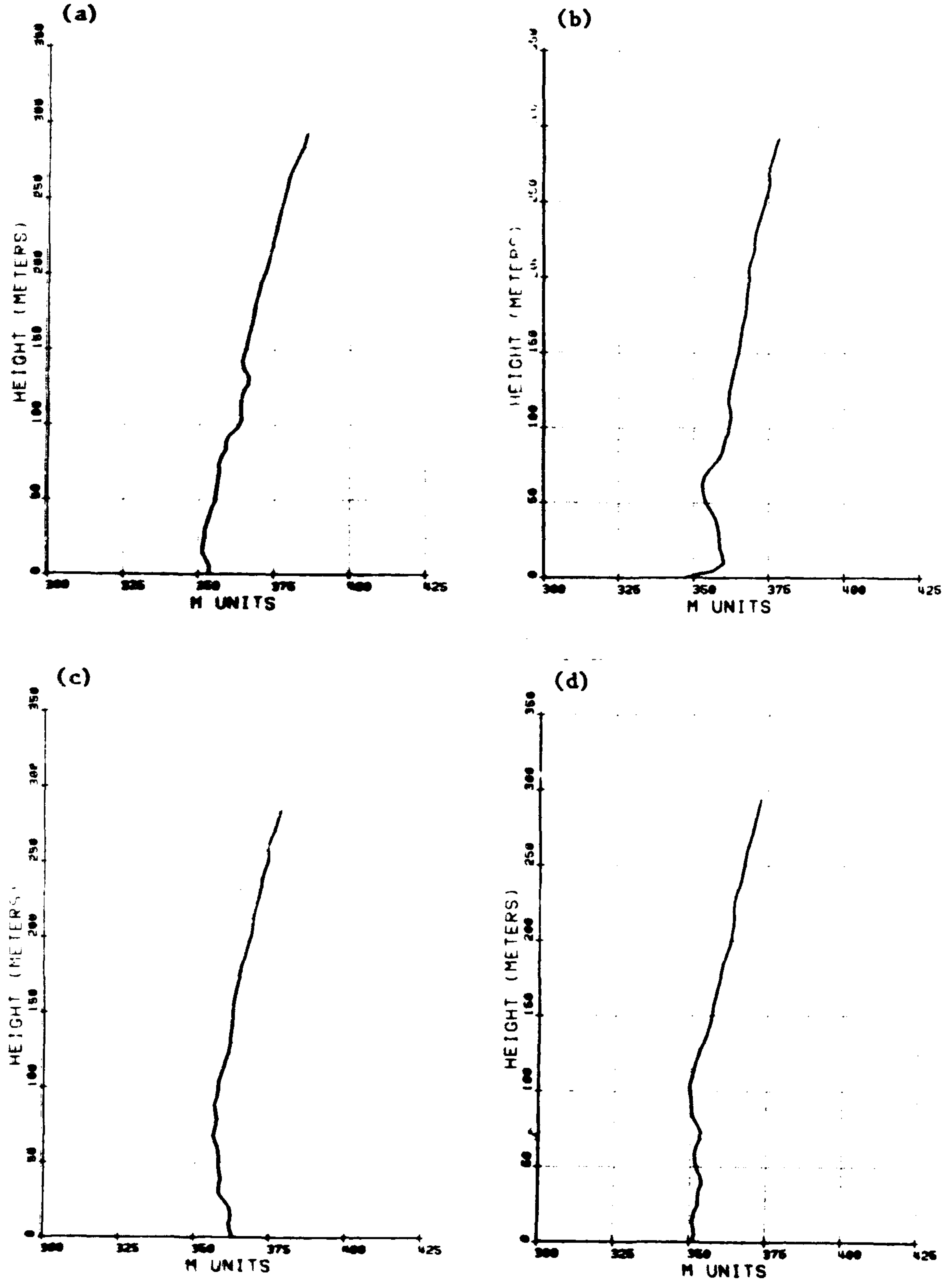


Figure 1-6 Case 1 M-Profiles : a. Cape San Blas, 31 Oct 78, 1600Z; b. Cape San Blas, 1 Nov 78, 0200Z; c. Cape San Blas, 1 Nov 78, 0400Z; d. Cape San Blas, 1 Nov 78, 1200Z.

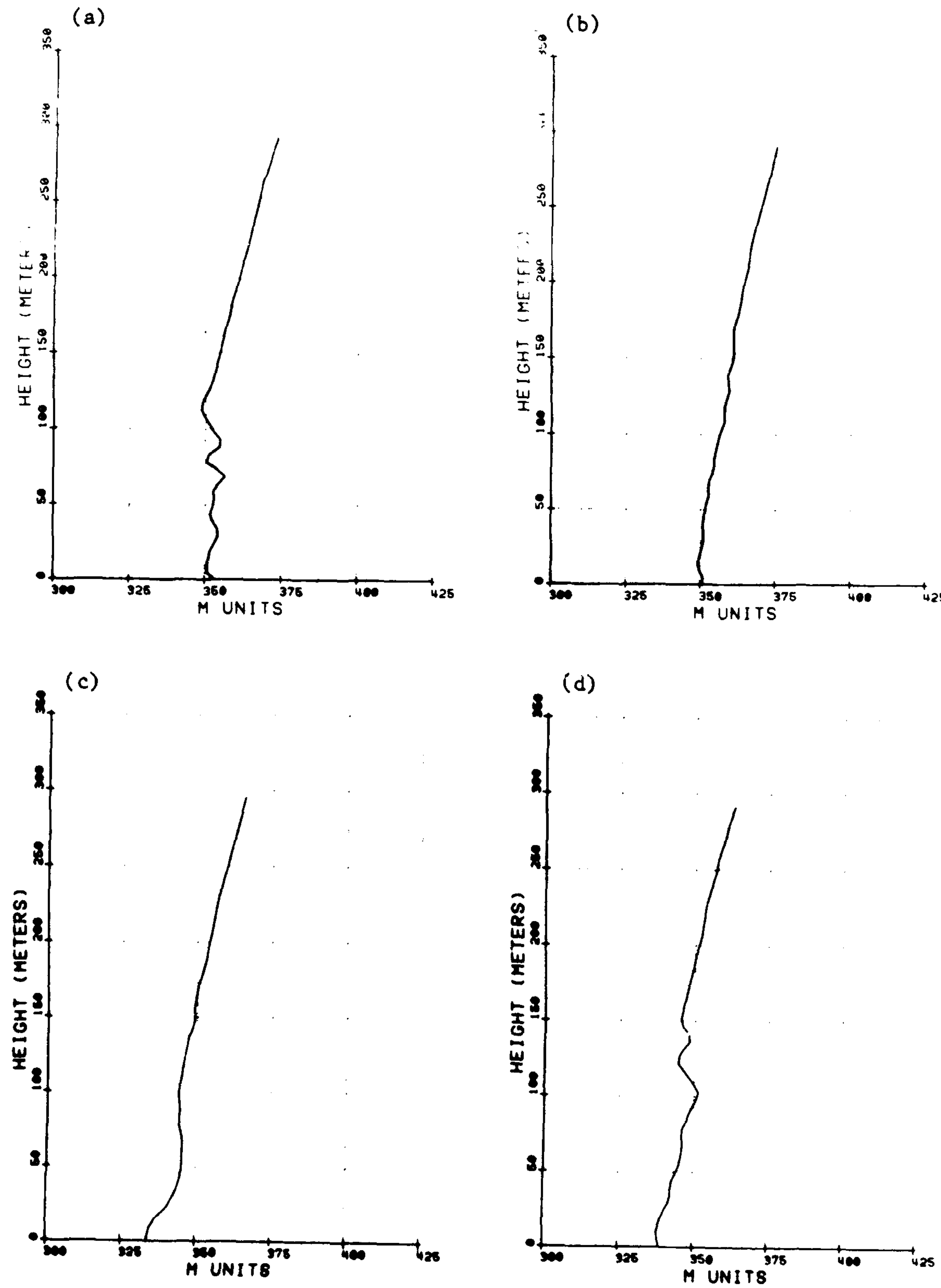


Figure 1-7 Case 1 M-Profiles: a. Cape San Blas, 1 Nov 78, 1400Z; b. Cape San Blas, 1 Nov 78, 1600Z; c. White City, 1 Nov 78, 1200Z; d. White City, 1 Nov 78, 1400Z.

(a)

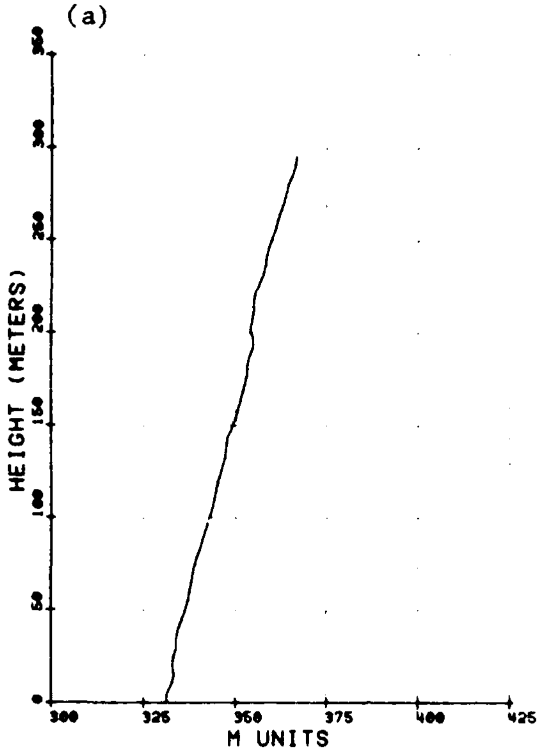


Figure 1-8 Case 1 M-Profile:
a. White City, 1 Nov 78, 1600Z.

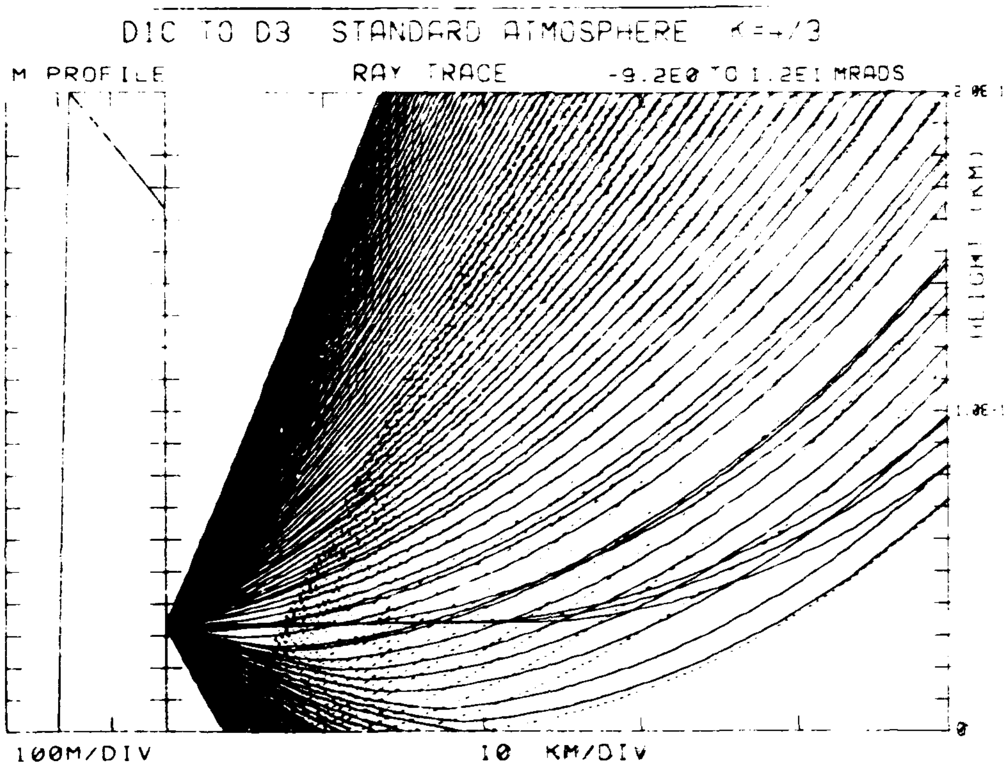


Figure 1-9 Typical Example of Standard Atmospheric Raytrace. **The height scale is 200 m and the range scale is 50 km. The D1C transmitter height (33.5 m MSL) was used.**

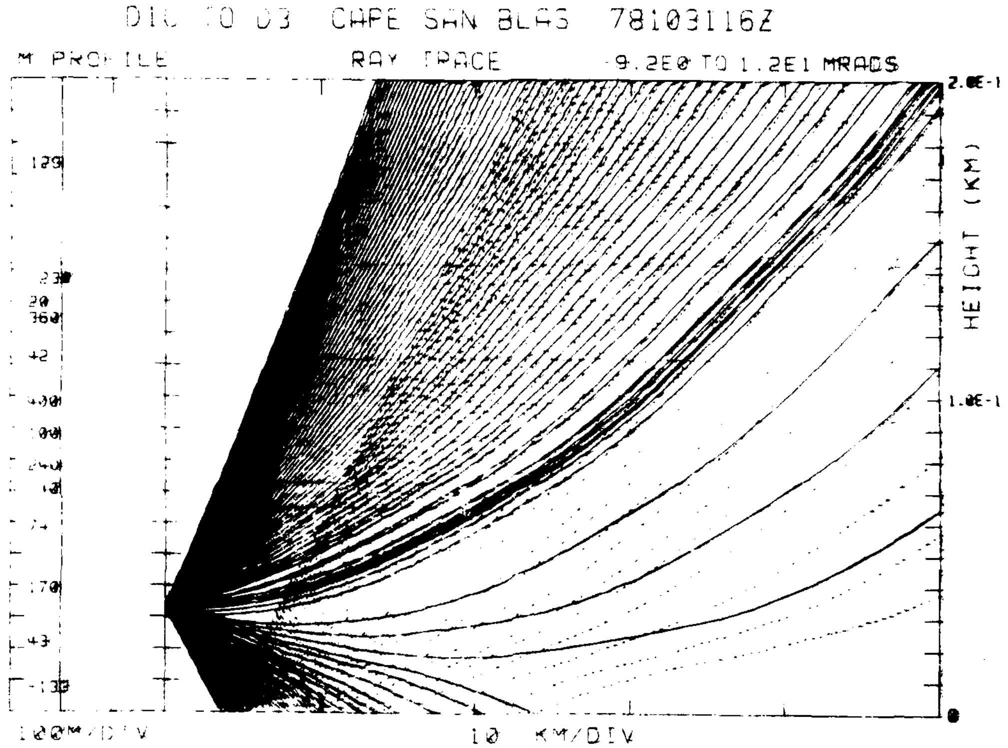


Figure 1-10 Case I Raytrace, DIC to D3, Cape San Blas, 31 Oct 78, 1600Z, Transmitter Height 33.5 m.

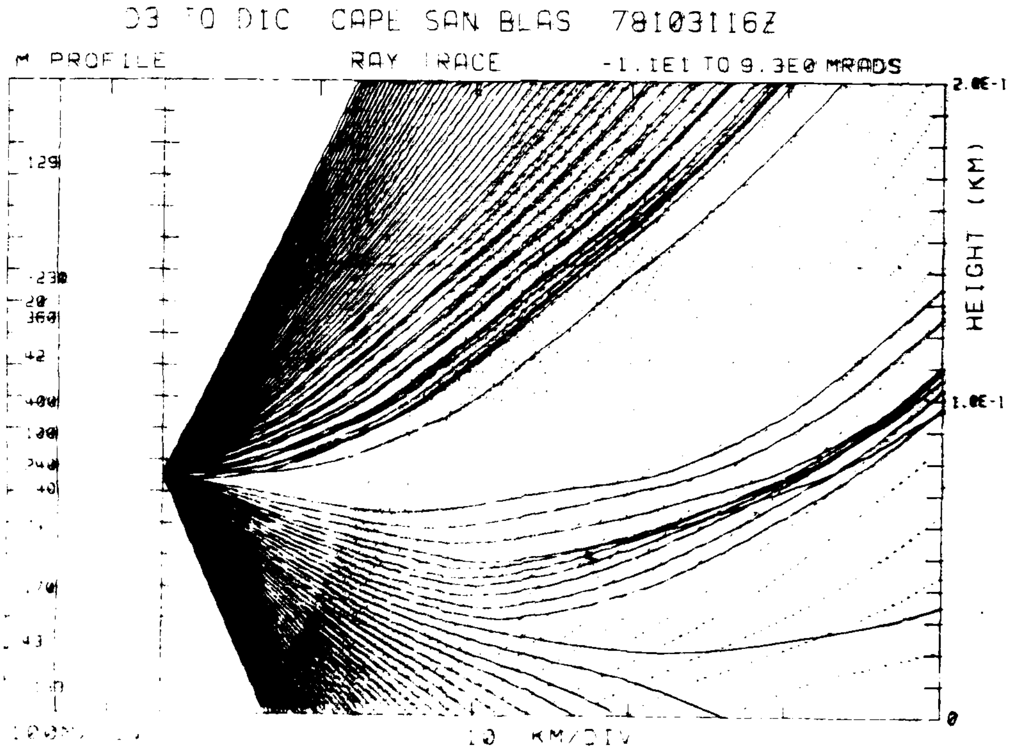


Figure 1-11. Case I Raytrace, D3 to DIC, Cape San Blas, 31 Oct 78, 1600Z, Transmitter Height 76.2 m.

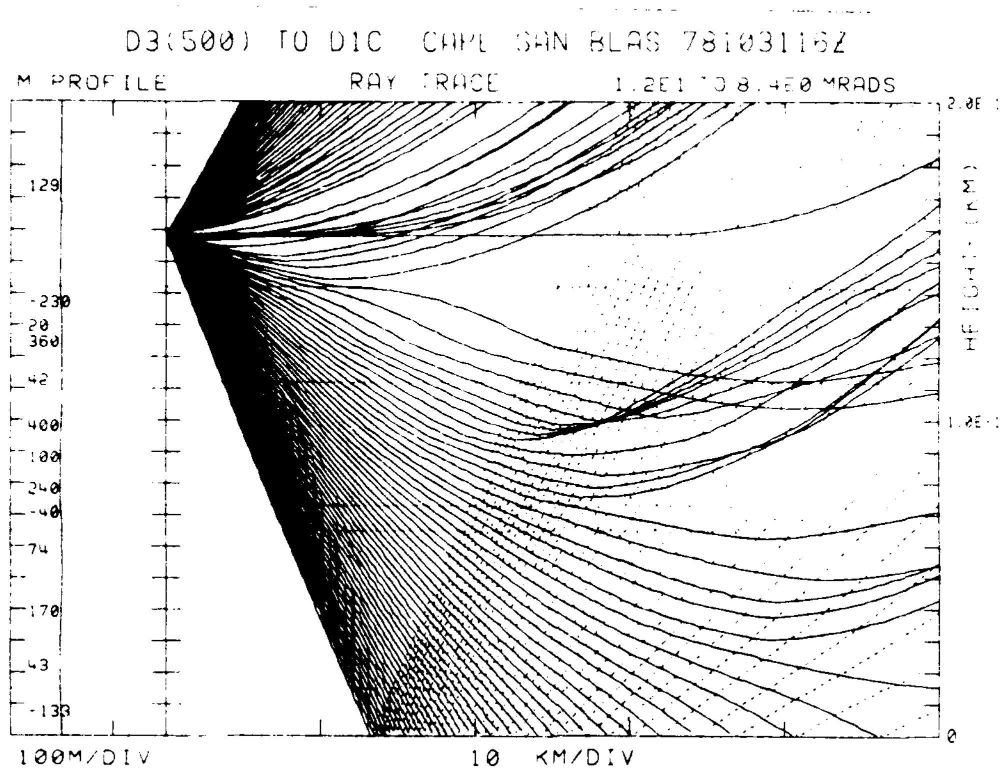


Figure 1-12 . **Case 1 Raytrace, D3(500) to D1C, Cape San Blas 31 Oct 78, 1600Z, Transmitter Height 158.4 m.**

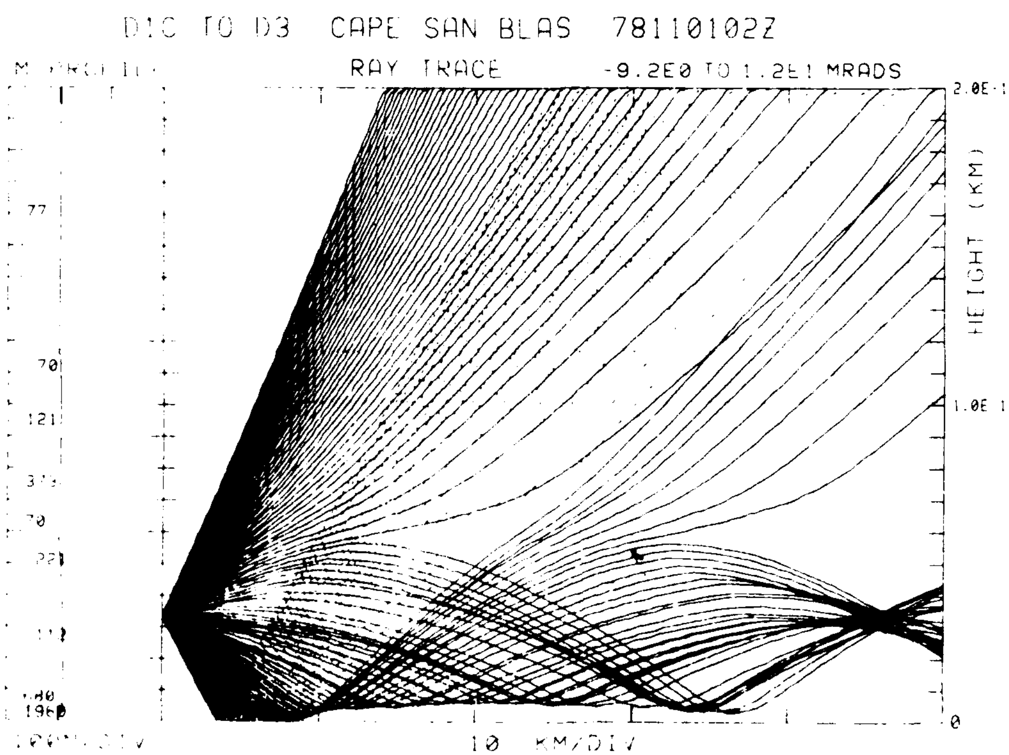


Figure 1-13 . **Case 1 Raytrace, D1C to D3, Cape San Blas, 1 Nov 78, 0200Z, Transmitter Height 33.5 m.**

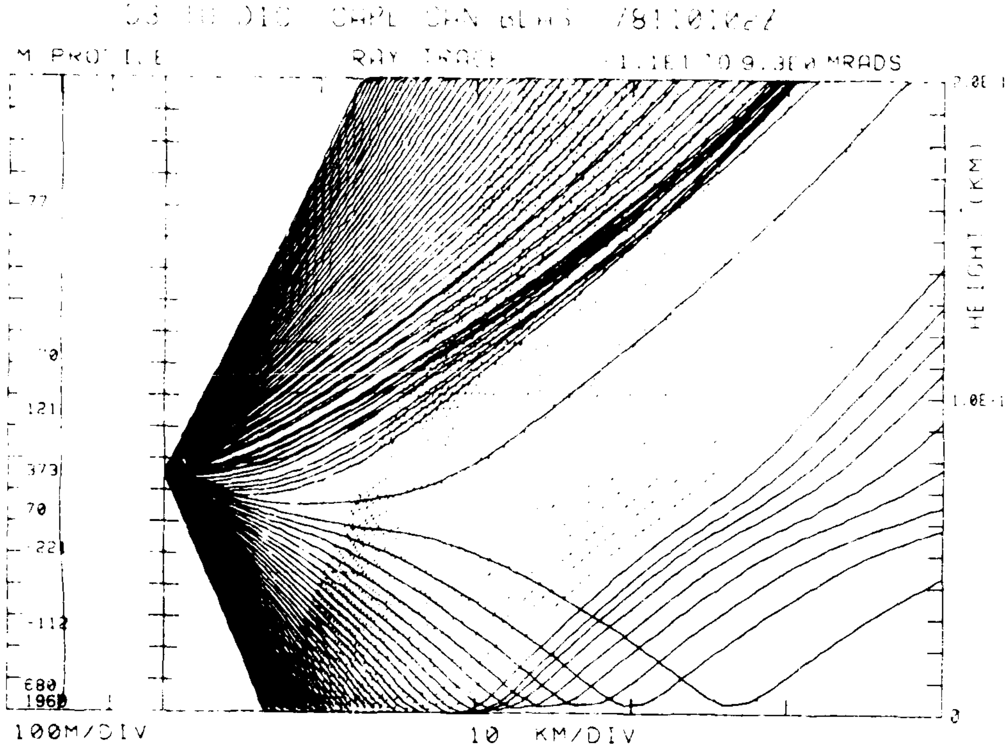


Figure 1-14. Case 1 Raytrace, D3 to D1C, Cape San Blas, 1 Nov 78, 0200Z, Transmitter Height 76.2 m.

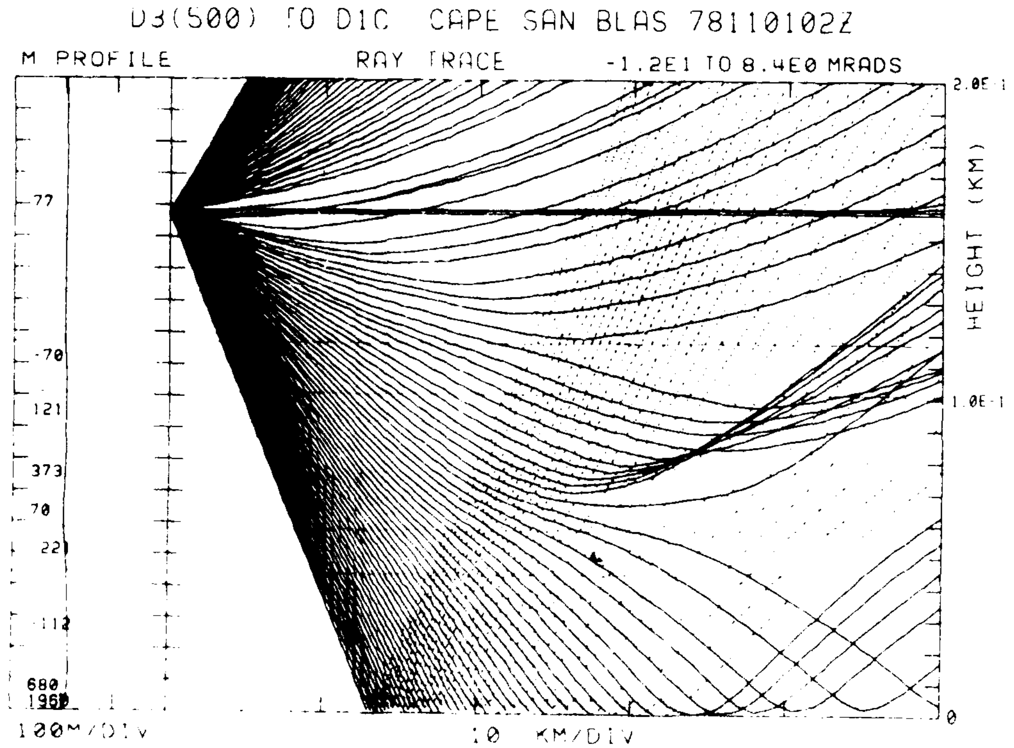


Figure 1-15. Case 1 Raytrace, D3(500) to D1C, Cape San Blas 1 Nov 78, 0200Z, Transmitter Height 158.4 m.

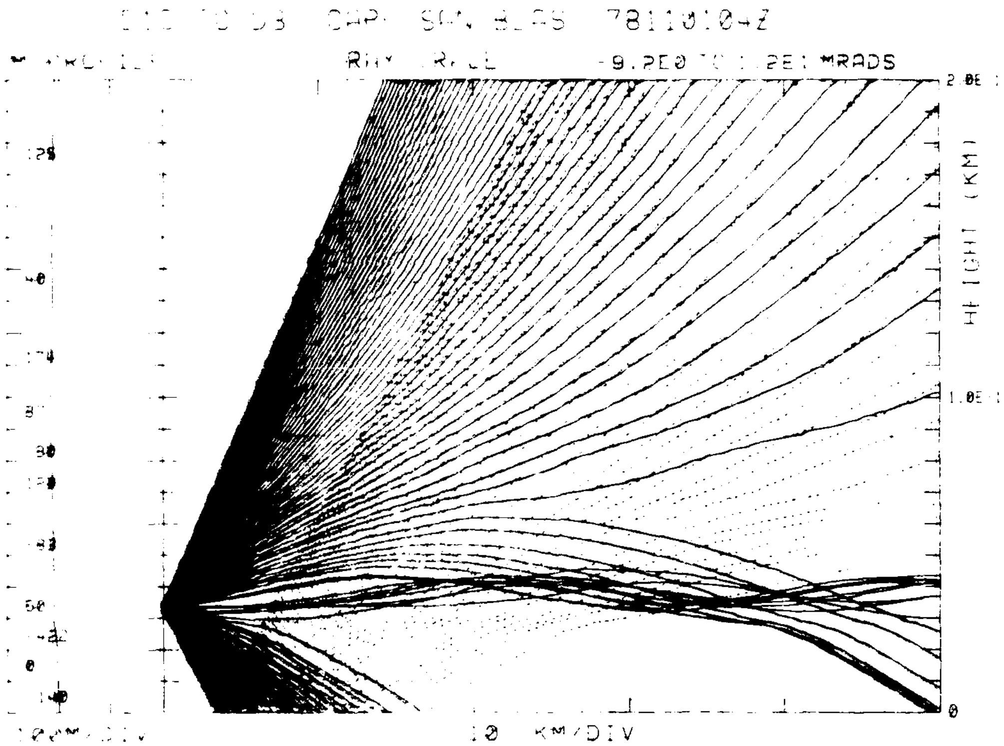


Figure 1-16. Case 1 Raytrace, D1C to D3, Cape San Blas, 1 Nov 78, 0400Z, Transmitter Height 33.5 m.

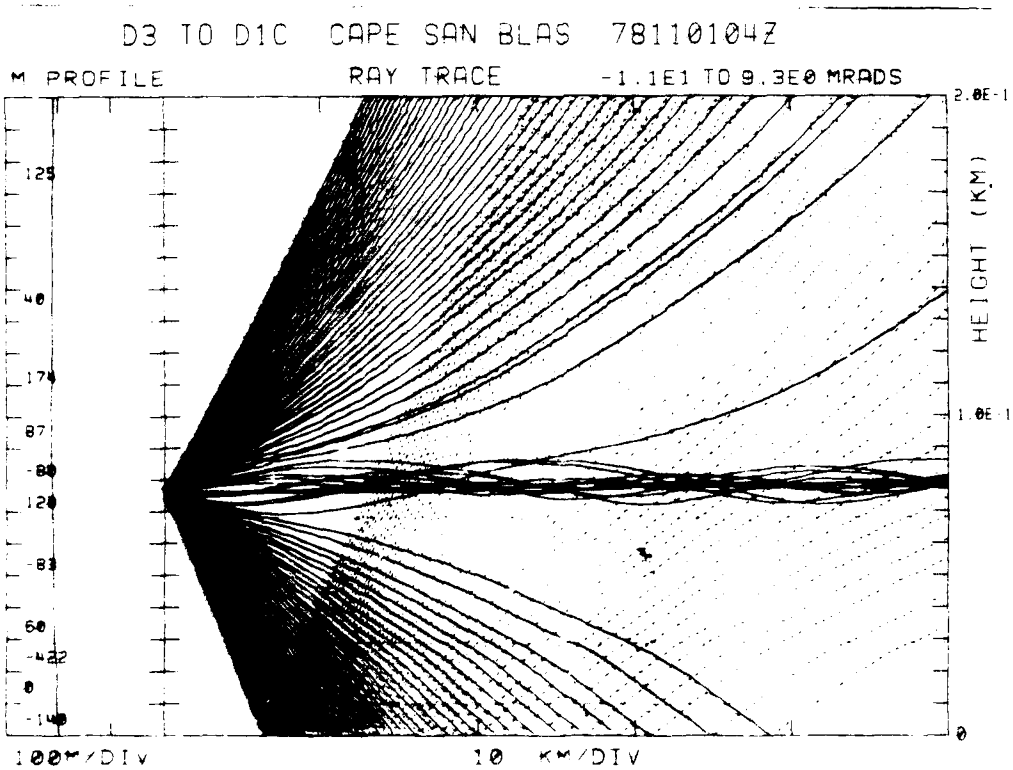


Figure 1-17. Case 1 Raytrace, D3 to D1C, Cape San Blas, 1 Nov 78, 0400Z, Transmitter Height 76.2 m.

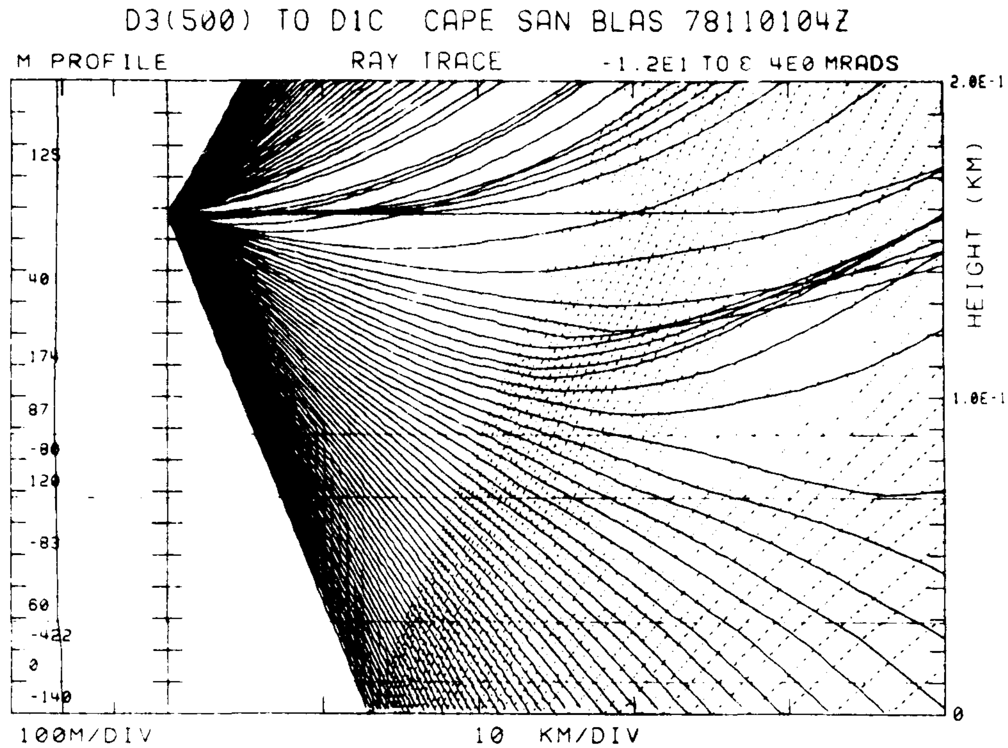


Figure 1-18 . Case 1 Raytrace, D3(500) to D1C, Cape San Blas 1 Nov 78, 0400Z, Transmitter Height 158.4 m.

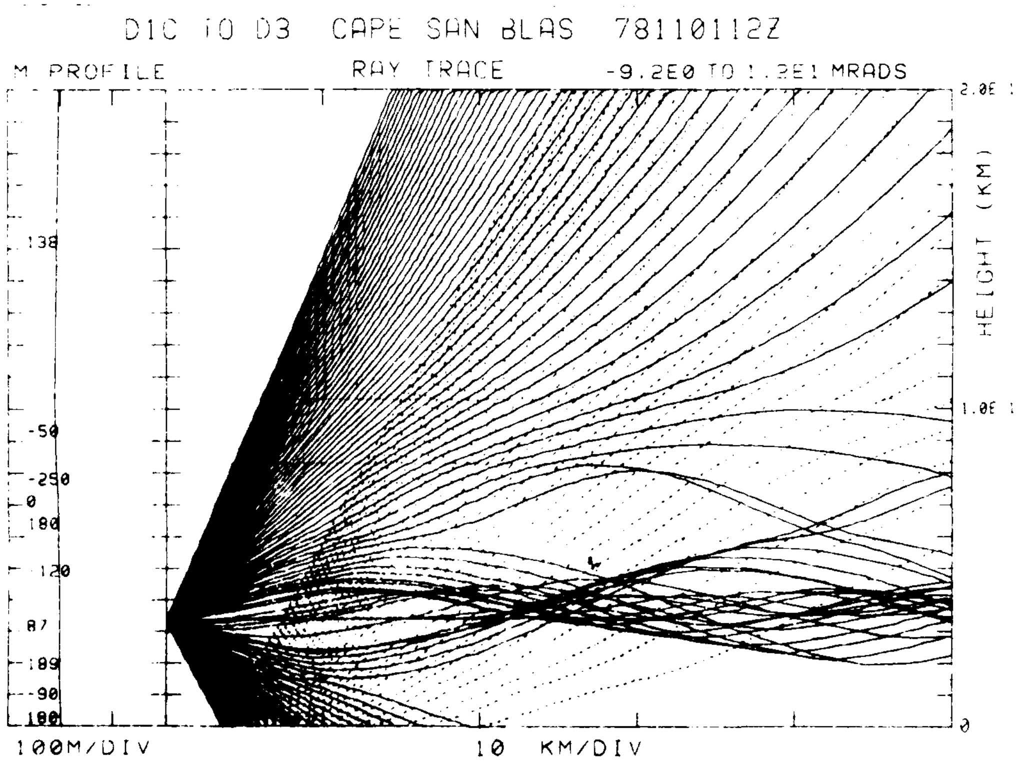


Figure 1-19. Case 1 Raytrace, D1C to D3, Cape San Blas, 1 Nov 78, 1200Z, Transmitter Height 33.5 m.

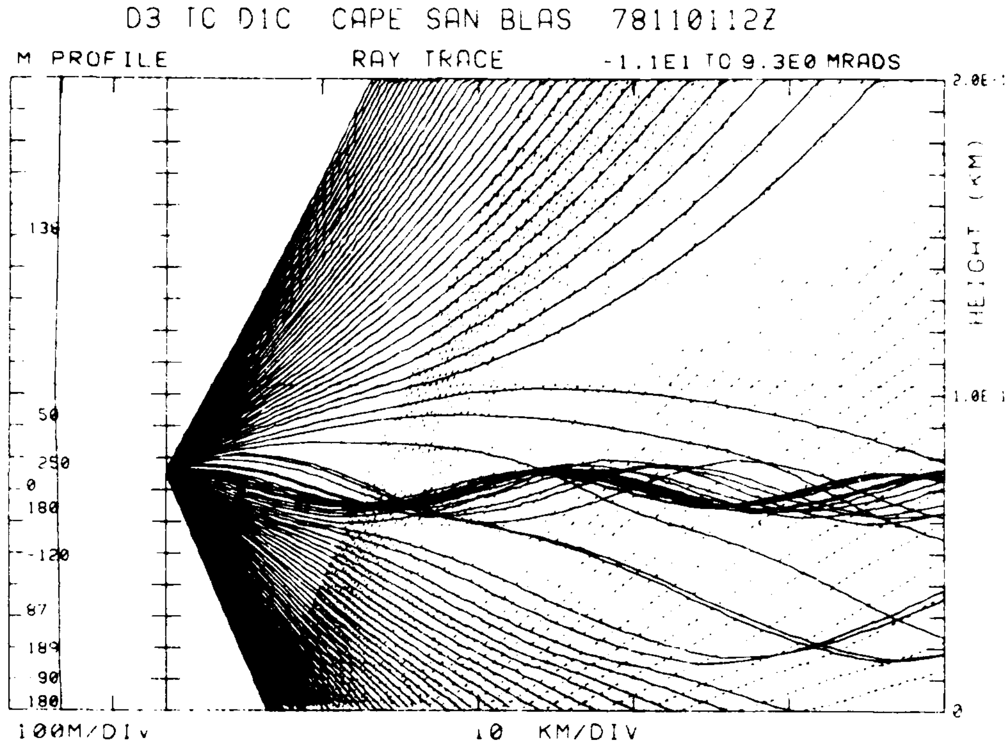


Figure 1-20. **Case 1 Raytrace, D3 to D1C, Cape San Blas, 1 Nov 78, 1200Z, Transmitter Height 76.2 m.**

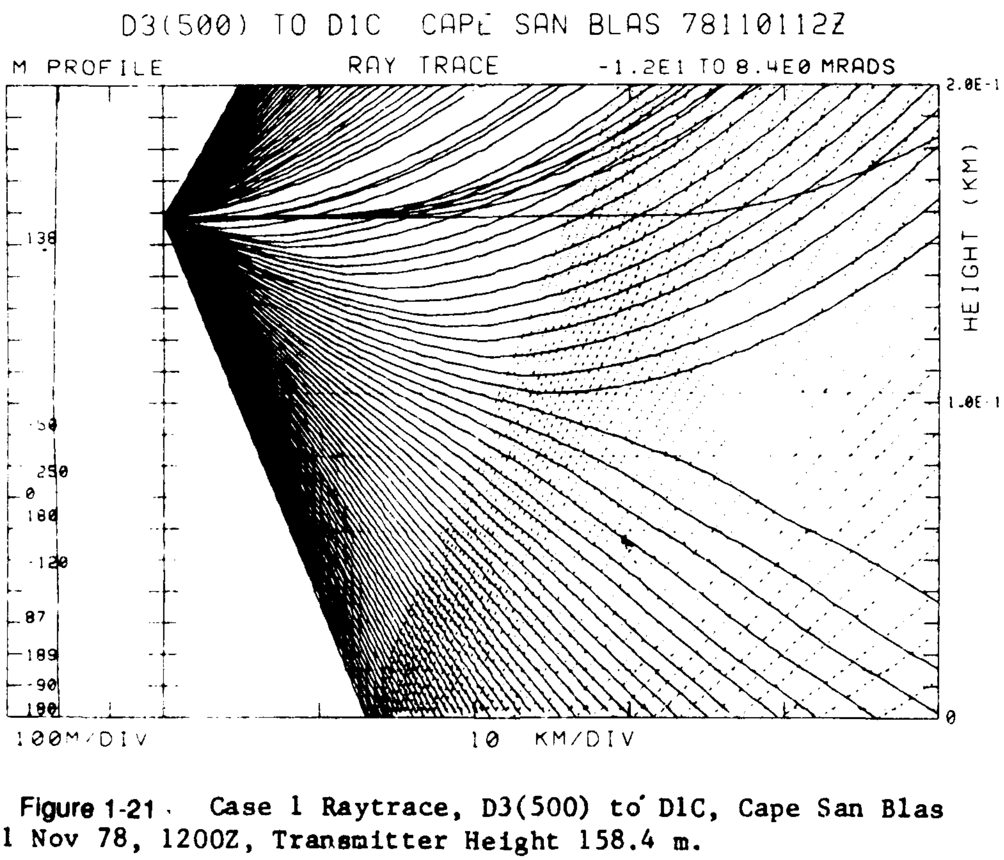


Figure 1-21. **Case 1 Raytrace, D3(500) to D1C, Cape San Blas 1 Nov 78, 1200Z, Transmitter Height 158.4 m.**

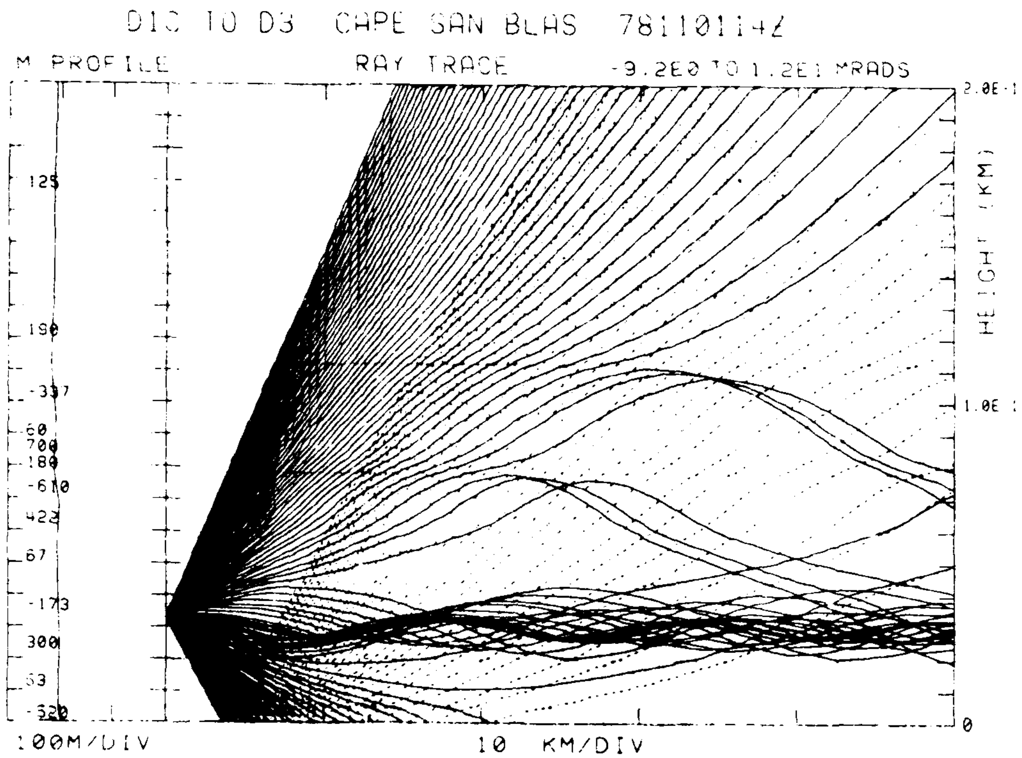


Figure 1-22. Case 1 Raytrace, D1C to D3, Cape San Blas, 1 Nov 78, 1400Z, Transmitter Height 33.5 m.

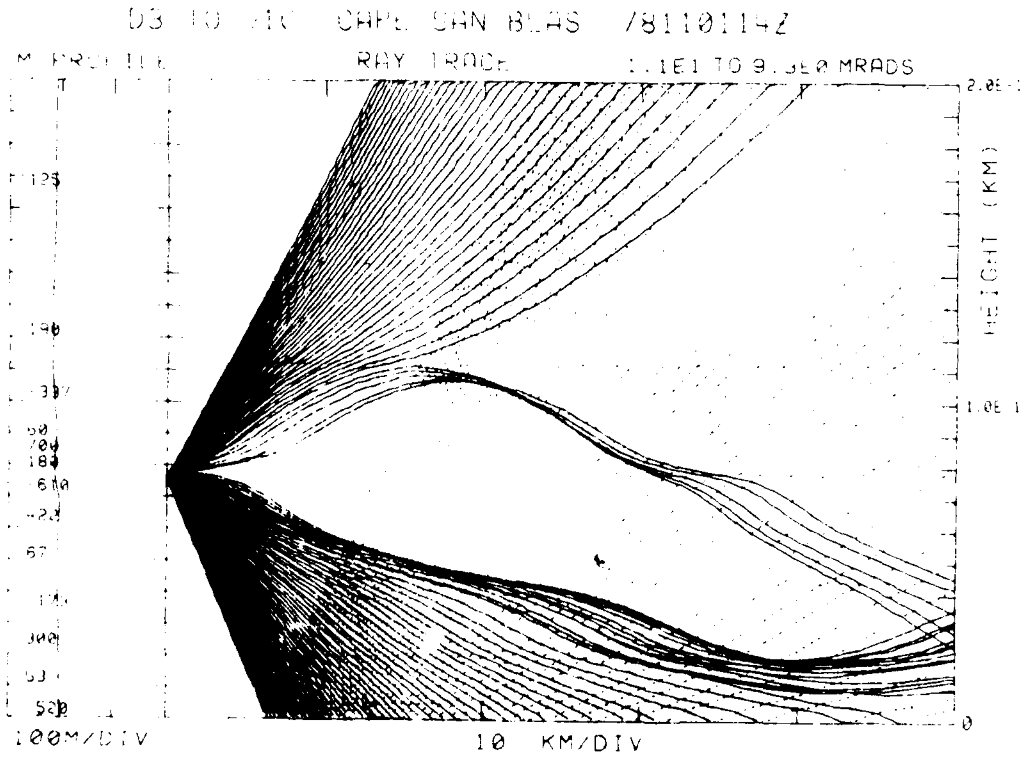


Figure 1-23. Case 1 Raytrace, D3 to D1C, Cape San Blas, 1 Nov 78, 1400Z, Transmitter Height 76.2 m.

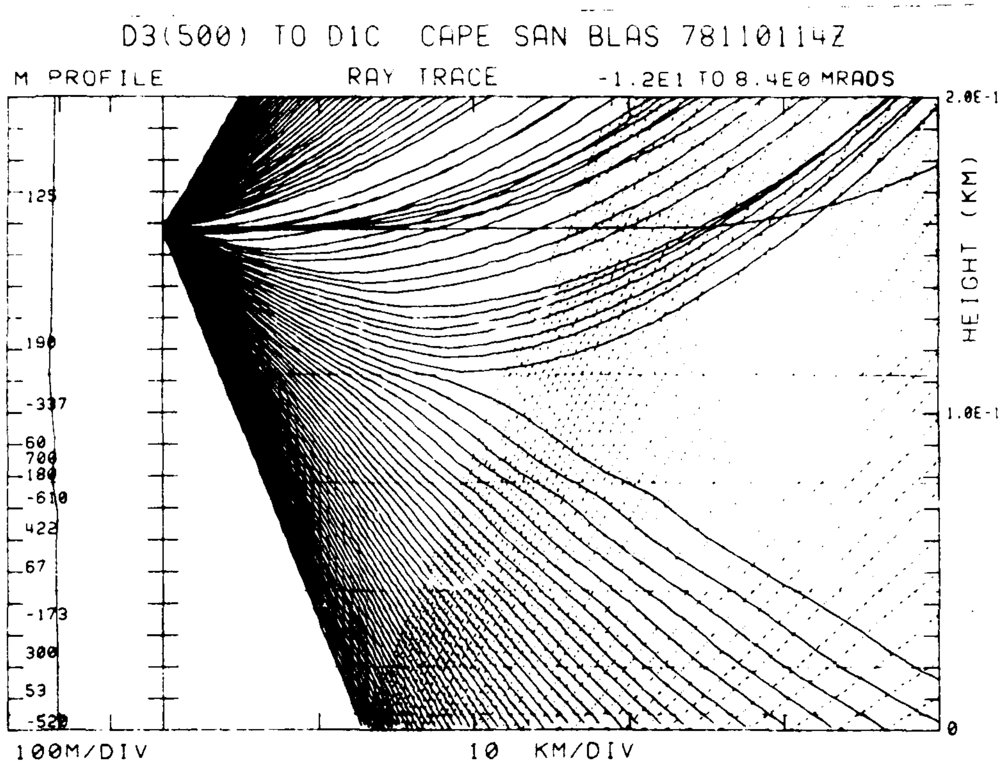


Figure 1-24. Case 1 Raytrace, D3(500) to D1C, Cape San Blas 1 Nov 78, 1400Z, Transmitter Height 158.4 m.

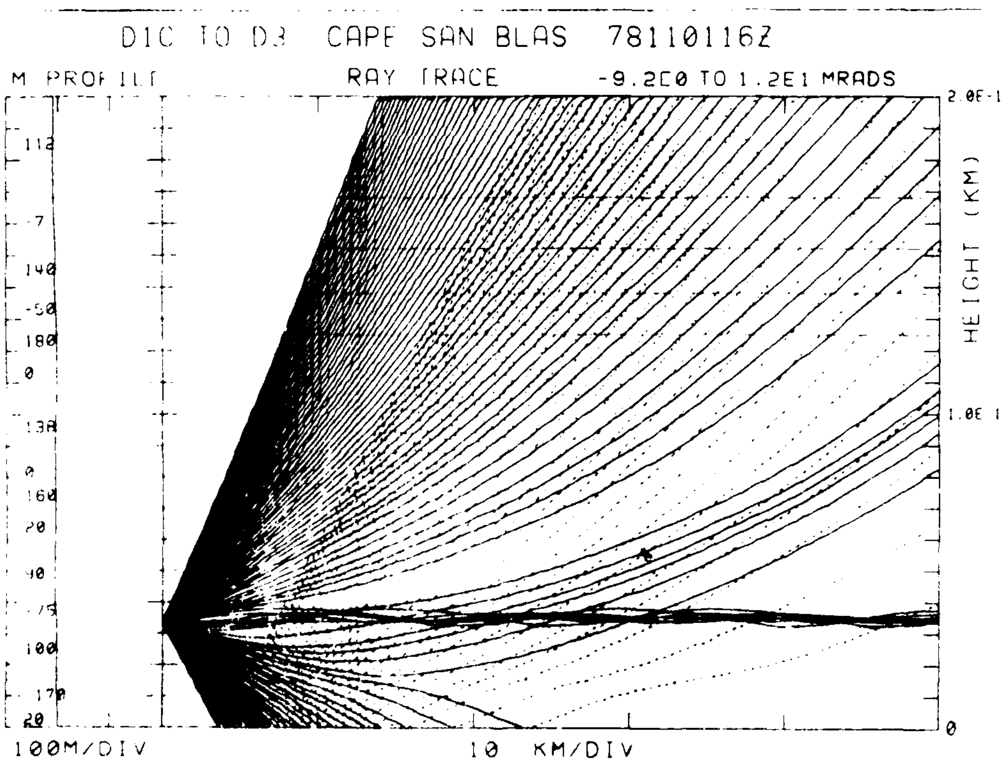


Figure 1-25. Case 1 Raytrace, D1C to D3, Cape San Blas, 1 Nov 78, 1600Z, Transmitter Height 33.5 m.

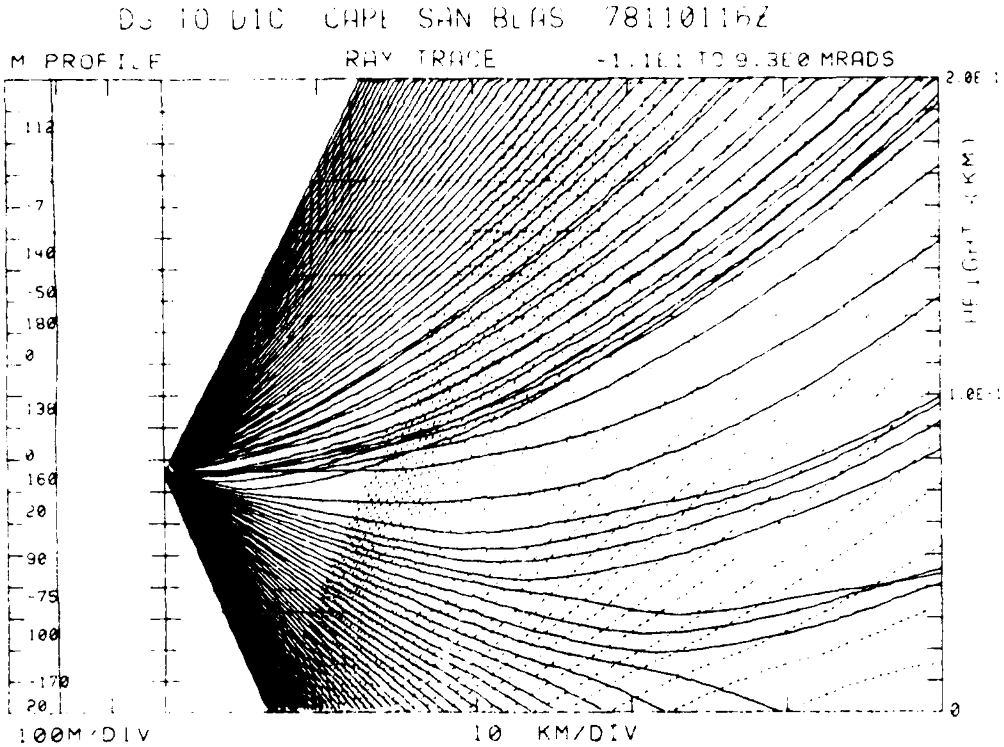


Figure 1-26. Case 1 Raytrace, D3 to D1C, Cape San Blas, 1 Nov 78, 1600Z, Transmitter Height 76.2 m.

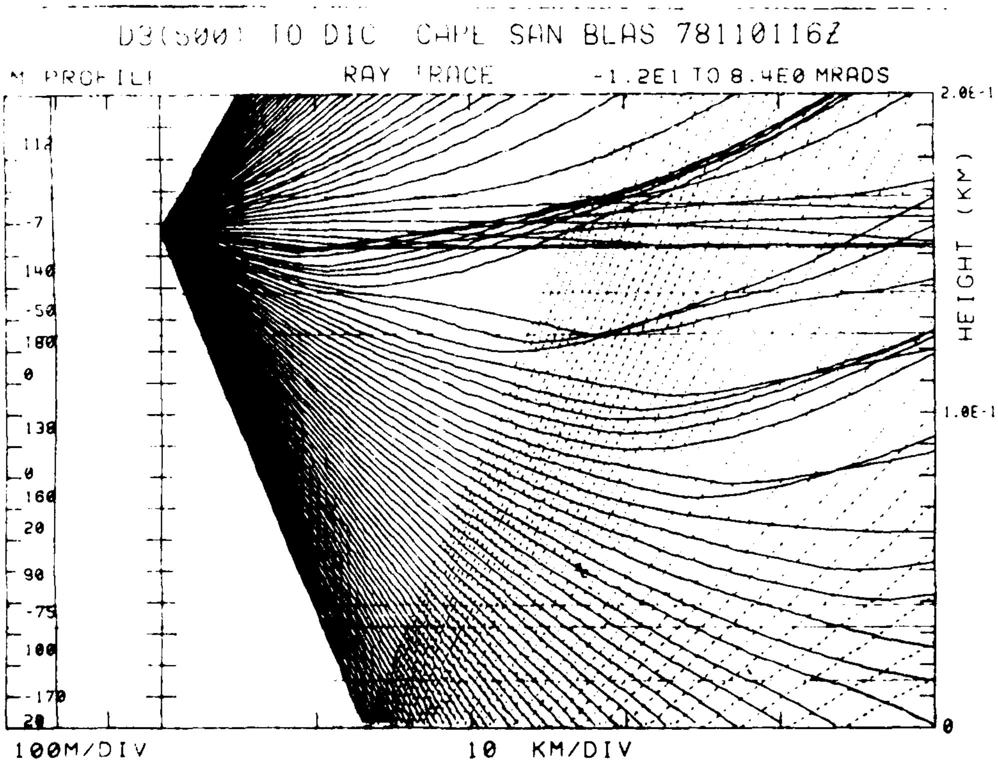


Figure 1-27. Case 1 Raytrace, D3(500) to D1C, Cape San Blas 1 Nov 78, 1600Z, Transmitter Height 158.4 m.

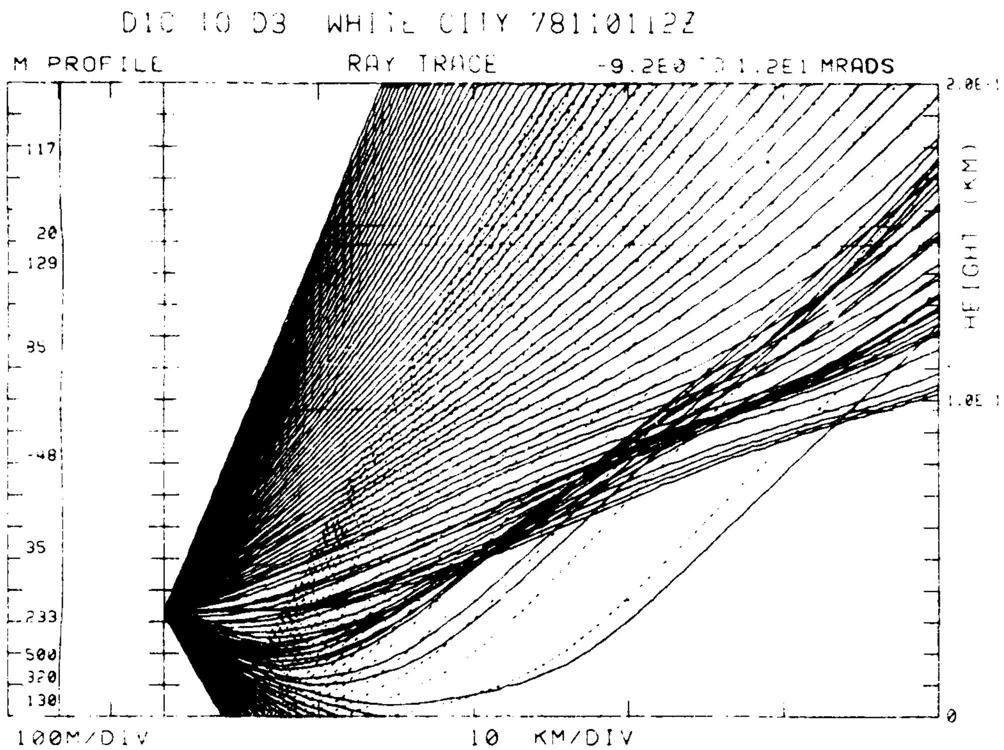


Figure 1-28 . **Case 1 Raytrace, D1C to D3, White City, 1 Nov 78, 1200Z, Transmitter Height 33.5 m.**

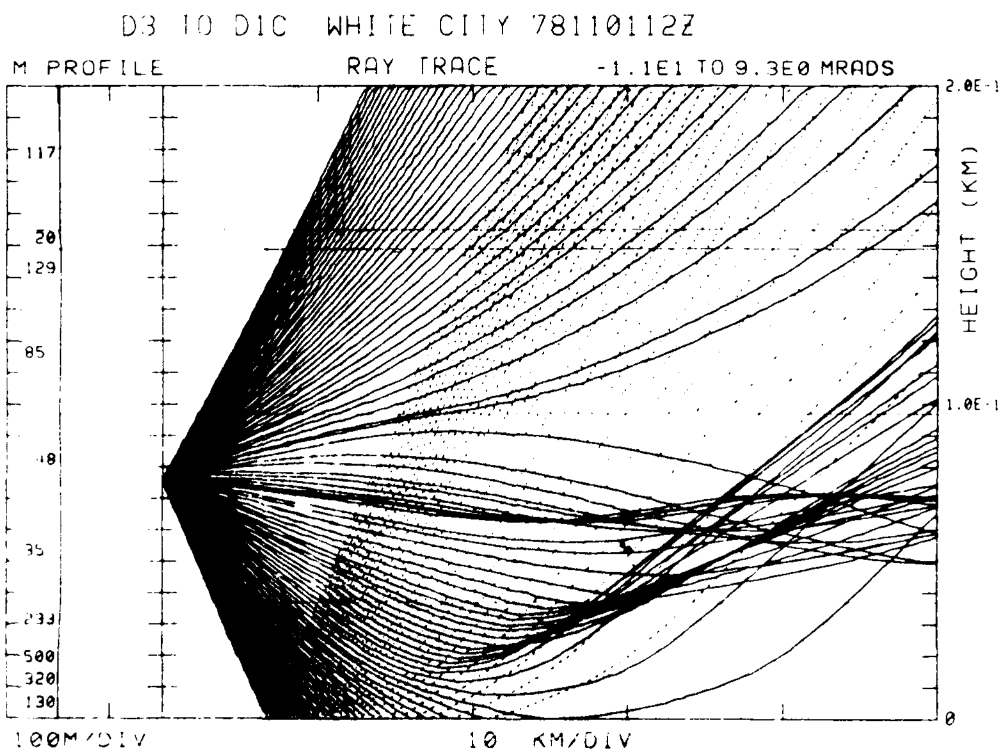


Figure 1-29 . **Case 1 Raytrace, D3 to D1C, White City, 1 Nov 78, 1200Z, Transmitter Height 76.2 m.**

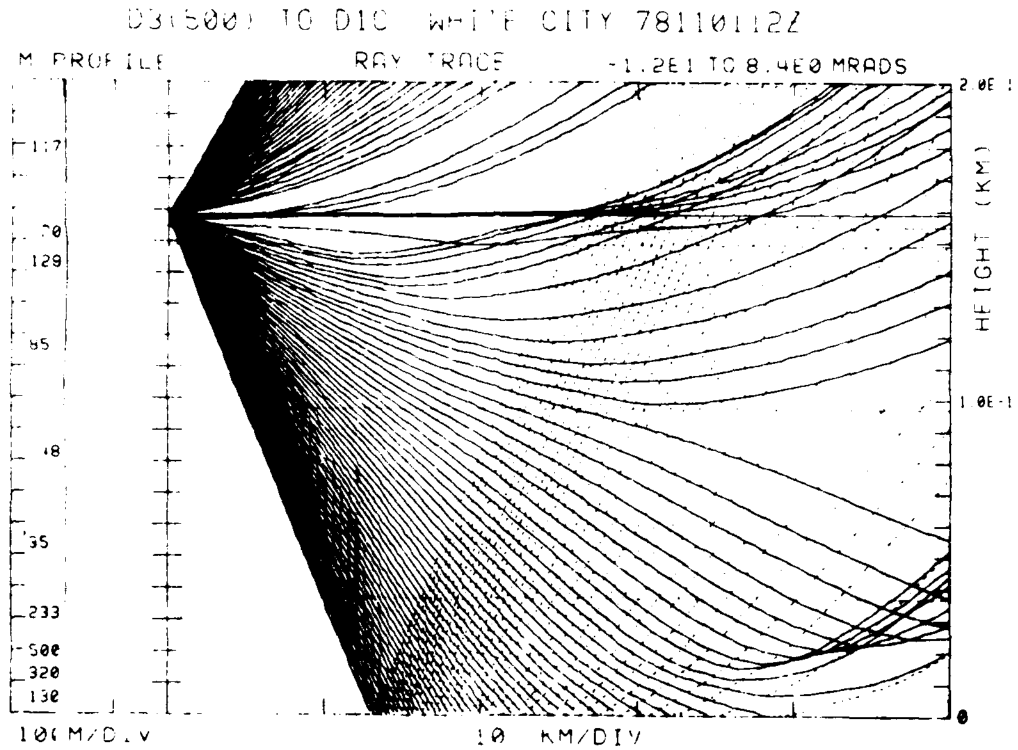


Figure 1-30 . Case 1 Raytrace, D3(500) to D1C, White City 1 Nov 78, 1200Z, Transmitter Height 158.4 m.

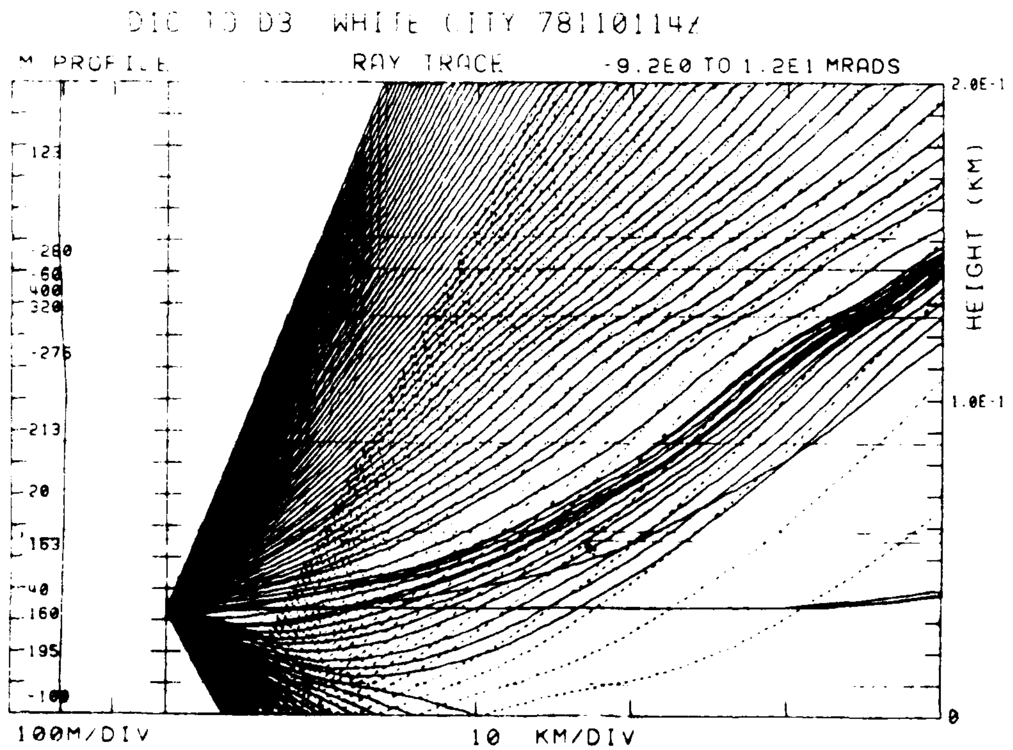


Figure 1-31 . Case 1 Raytrace, D1C to D3, White City, 1 Nov 78, 1400Z, Transmitter Height 33.5 m.

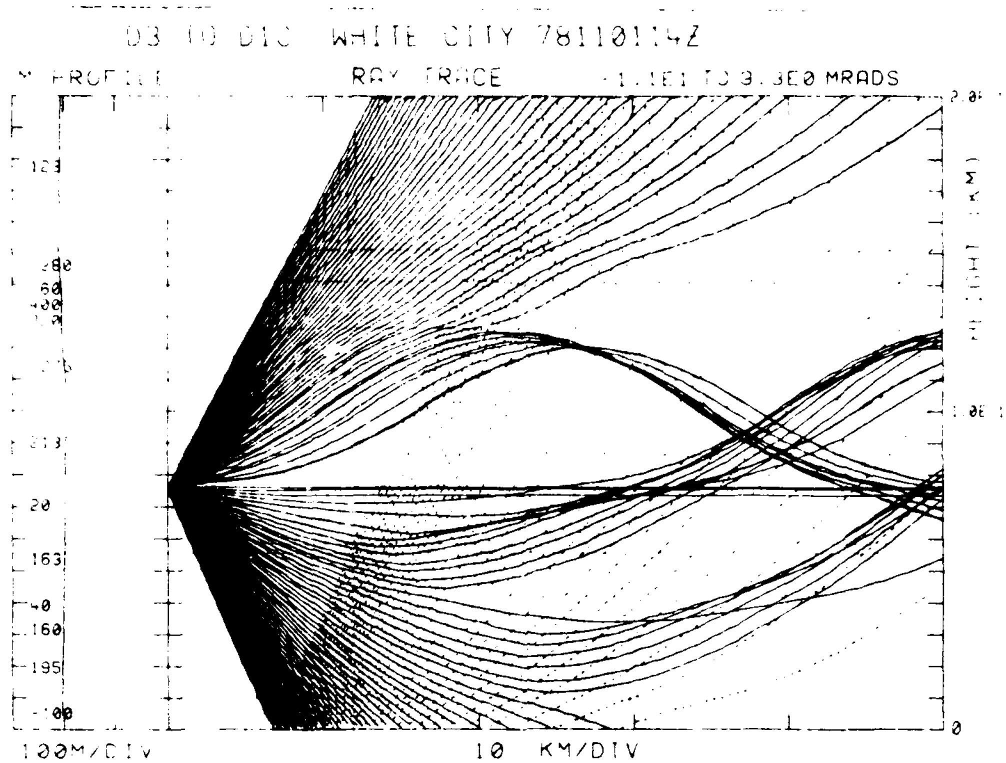


Figure 1-32. Case 1 Raytrace, D3 to DlC, White City, 1 Nov 78, 1400Z, Transmitter Height 76.2 m.

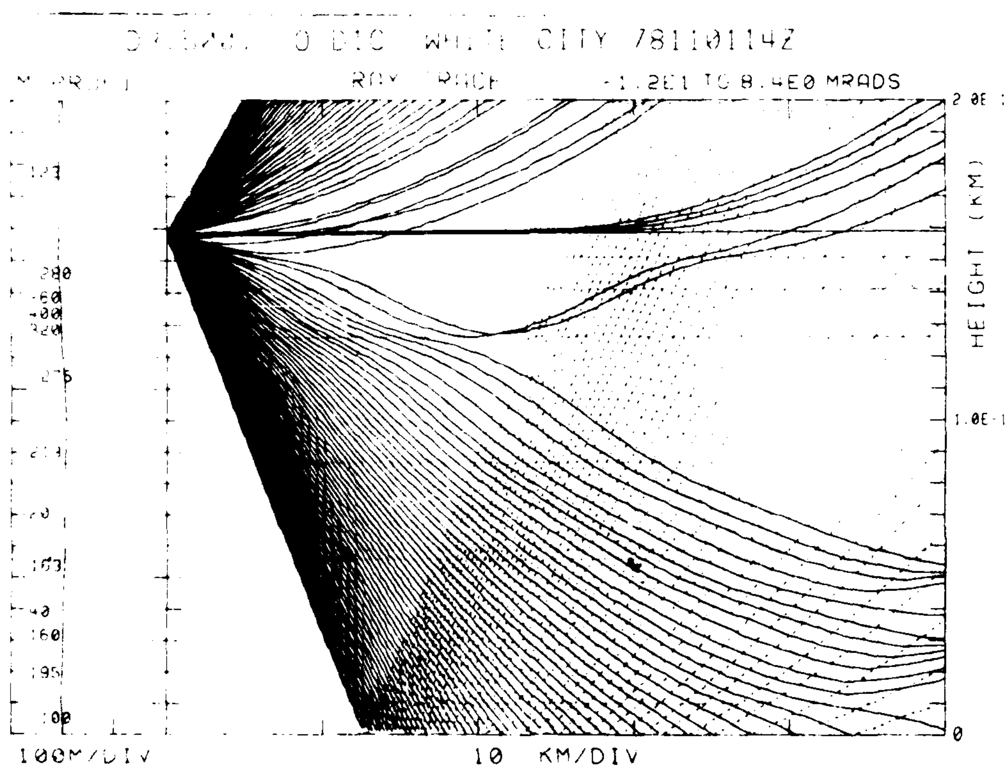


Figure 1-33. Case 1 Raytrace, D3(500) to DlC, White City 1 Nov 78, 1400Z, Transmitter Height 158.4 m.

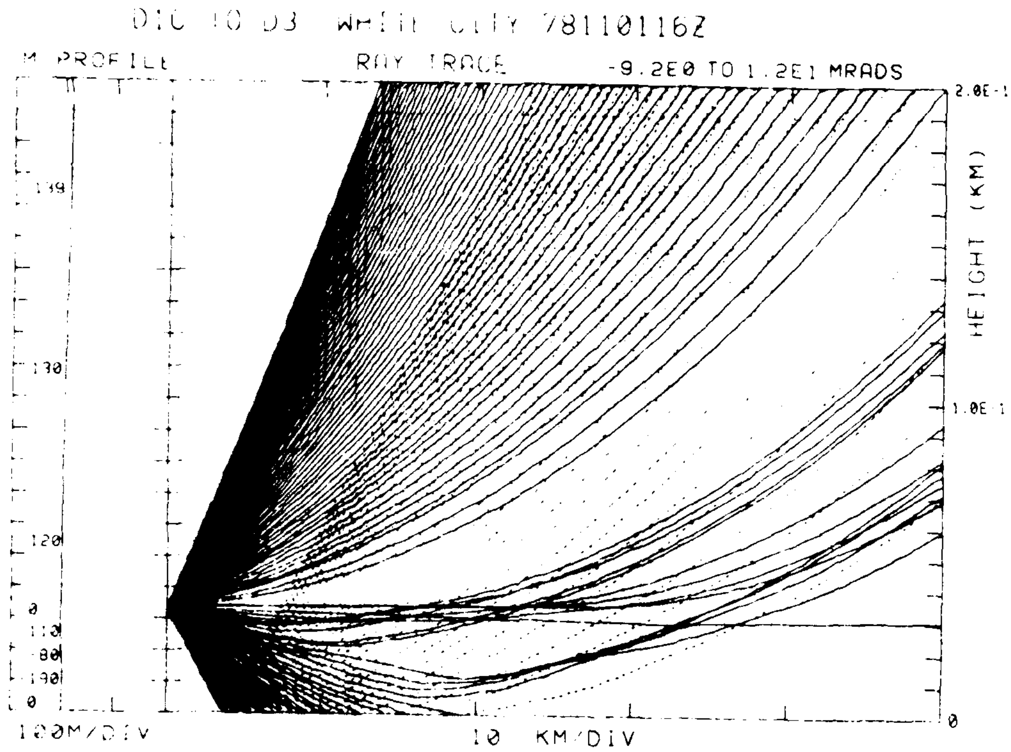


Figure 1-34. Case 1 Raytrace, D1C to D3, White City, 1 Nov 78, 1600Z, Transmitter Height 33.5 m.

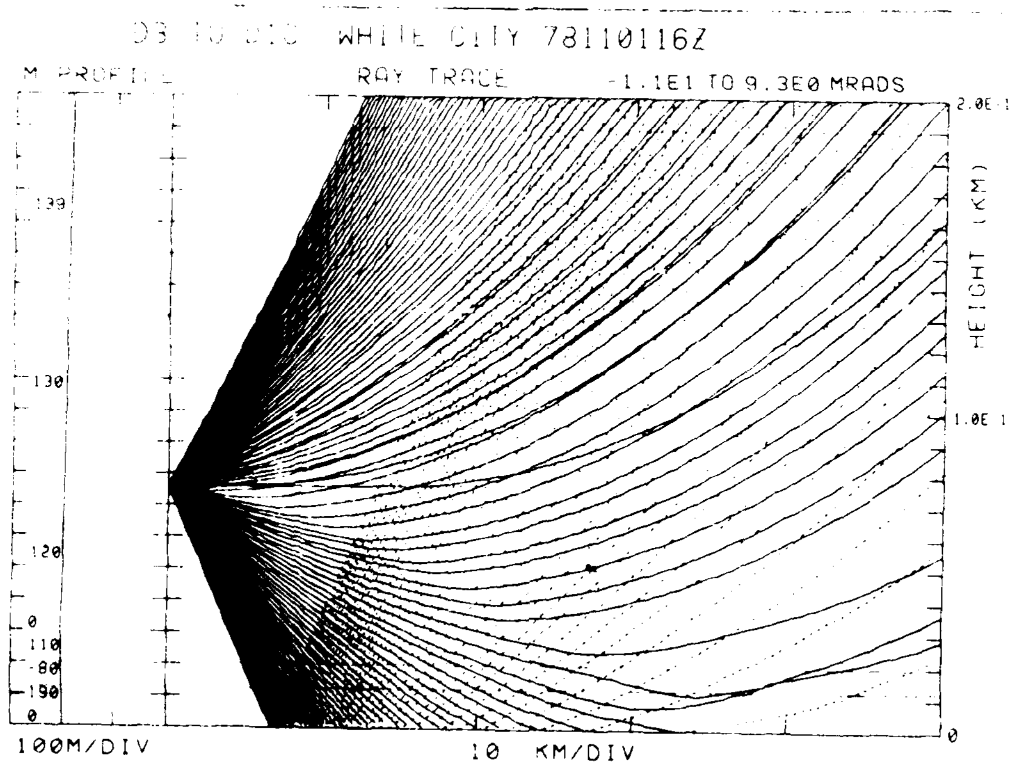


Figure 1-35. Case 1 Raytrace, D3 to D1C, White City, 1 Nov 78, 1600Z, Transmitter Height 76.2 m.

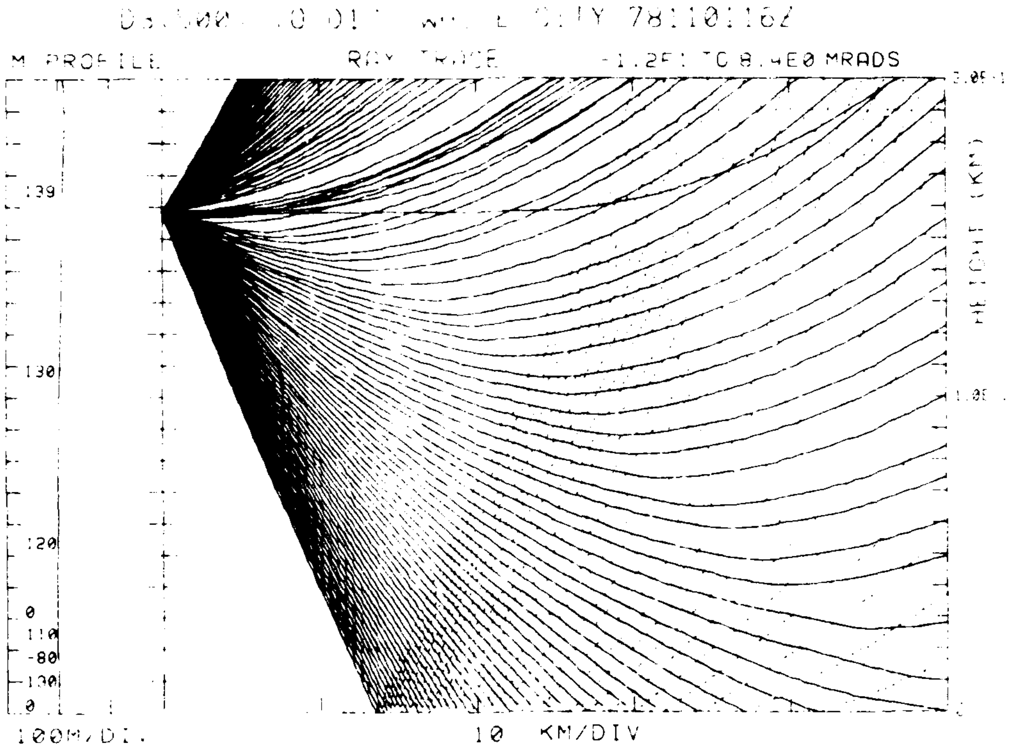


Figure 1-36. Case 1 Raytrace, D3(500) to D1C, White City 1 Nov 78, 1600Z, Transmitter Height 158.4 m.

CASE 2

1. Case 2 (3 November, 02-18Z) is, in many respects, very similar to Case 1. The same path variables (D1C-D3) were involved, and general weather conditions were similar. Figure 2-1 denotes a typical RSL recording for the period.

2. Synoptic weather is Shown in Figures 2-2 through 2-4. Once again, a very weak pressure gradient was evident, and surface winds were calm to weak northerly. Fog and haze were prevalent during early-morning hours, and no precipitation was detected by the Apalachicola radar.

3. The observations at all three surface reporting stations (Tables 2-1 through 2-3) confirm the synoptic pattern.

4. The M-profiles for this case (Figures 2-5 and 2-6) differ from those of Case 1 in that numerous fluctuations are not nearly as evident; however, a larger scale duct is present in many of the profiles. In fact, White City had a more pronounced duct than did Cape San Blas.

5. Raytraces for this case are shown in Figures 2-7 through 2-30. Once again, the direct ray beam pattern improves significantly with the D3 transmitting antenna raised to 158.4 meters. Improvement is best in terms of ray density at shorter ranges.

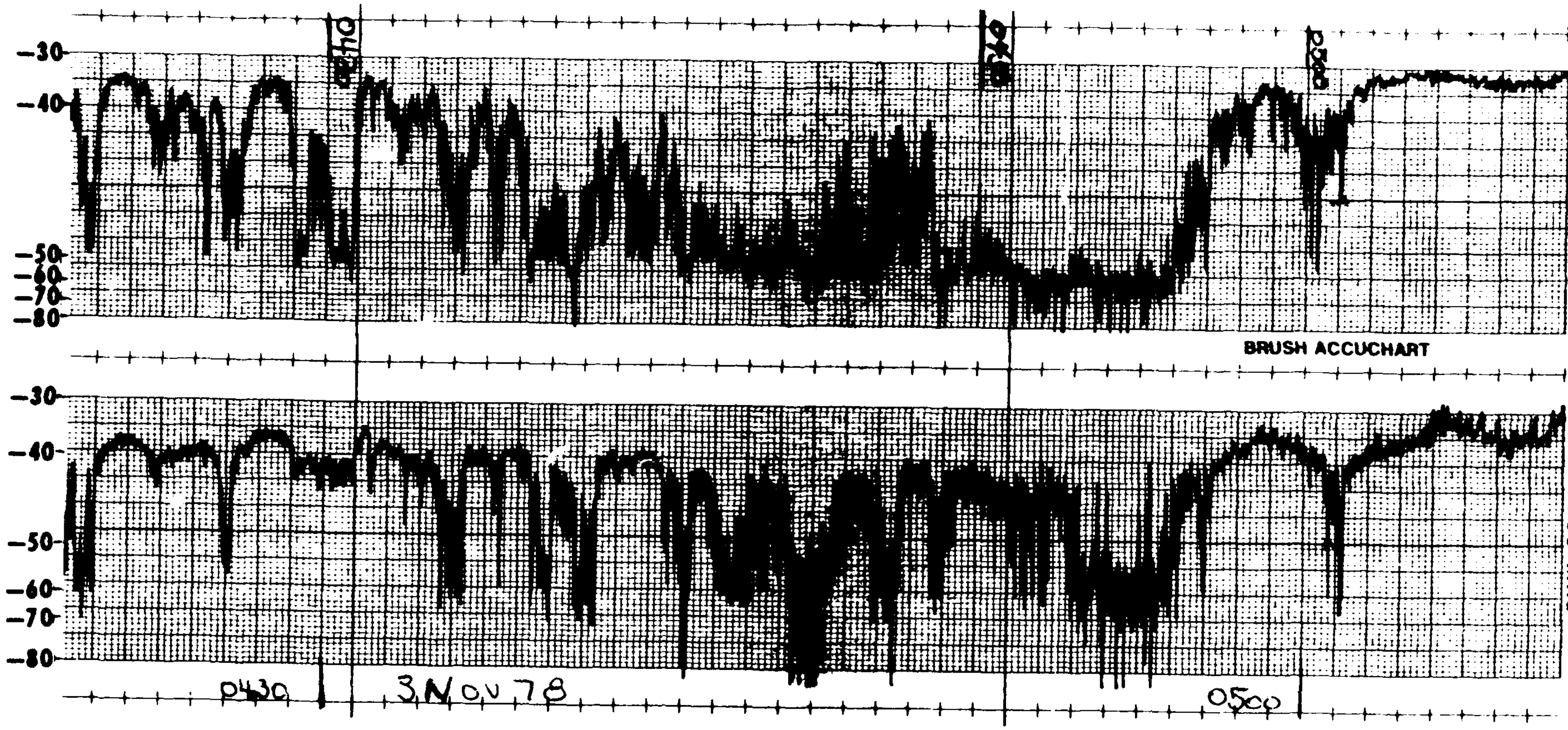


Figure 2-1 Case 2 RSL Strip Chart showing typical *fade* pattern of both channels of D1C received from D3. Times are from 0422 CST to 0508 CST, 3 Nov 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

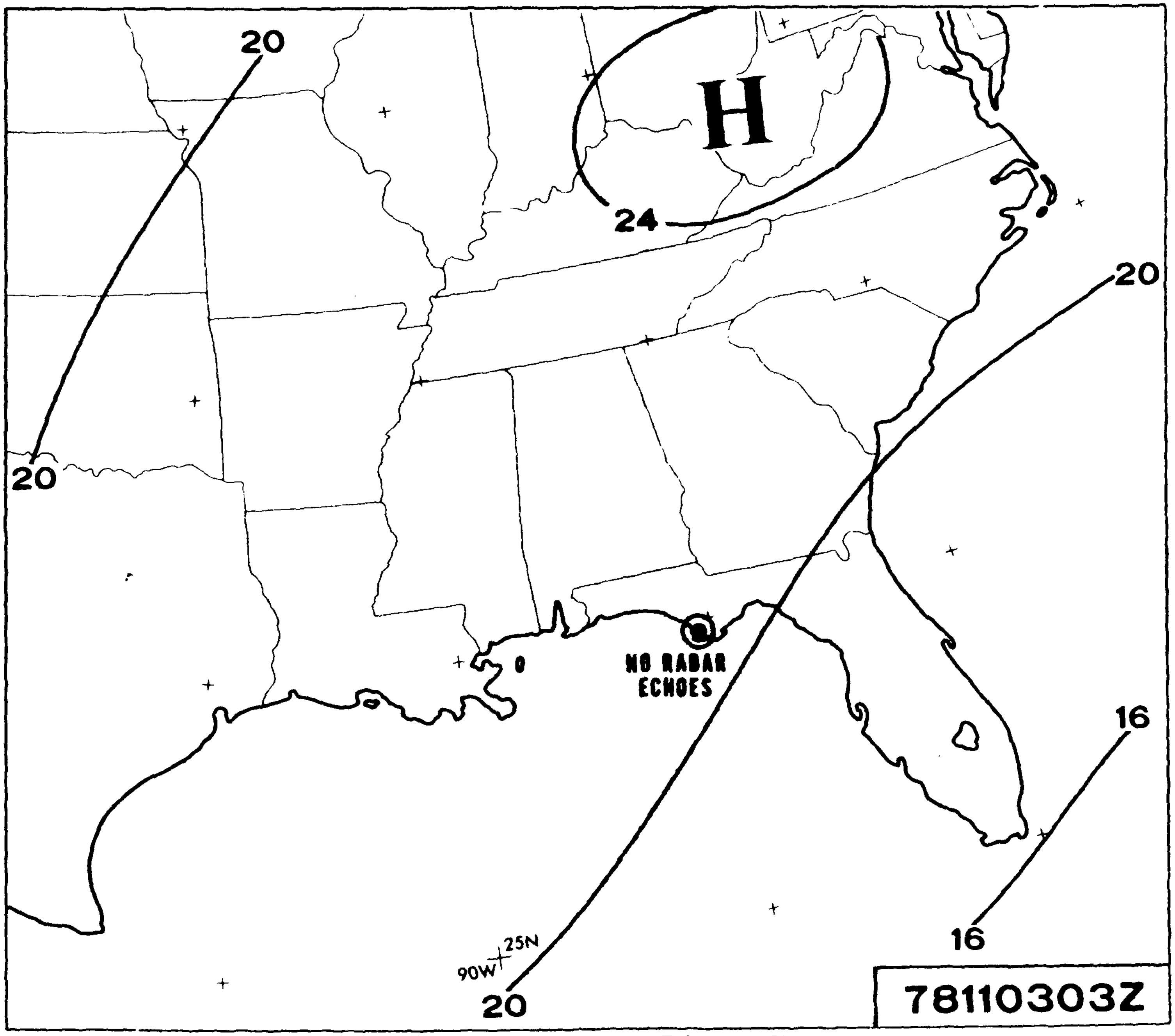


Figure 2-2 78110303Z Synoptic Chart

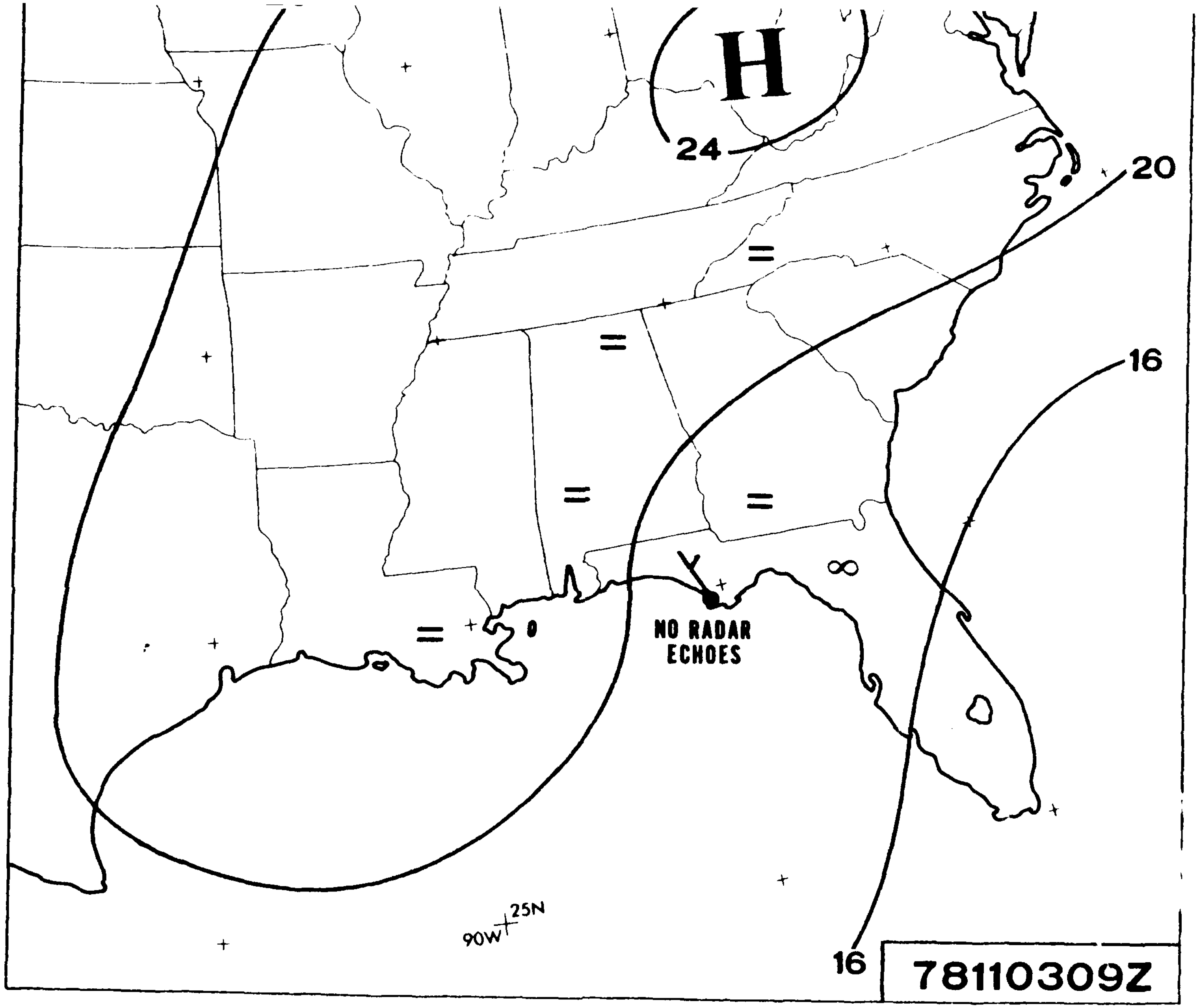


Figure 2-3 78110309Z Synoptic Chart

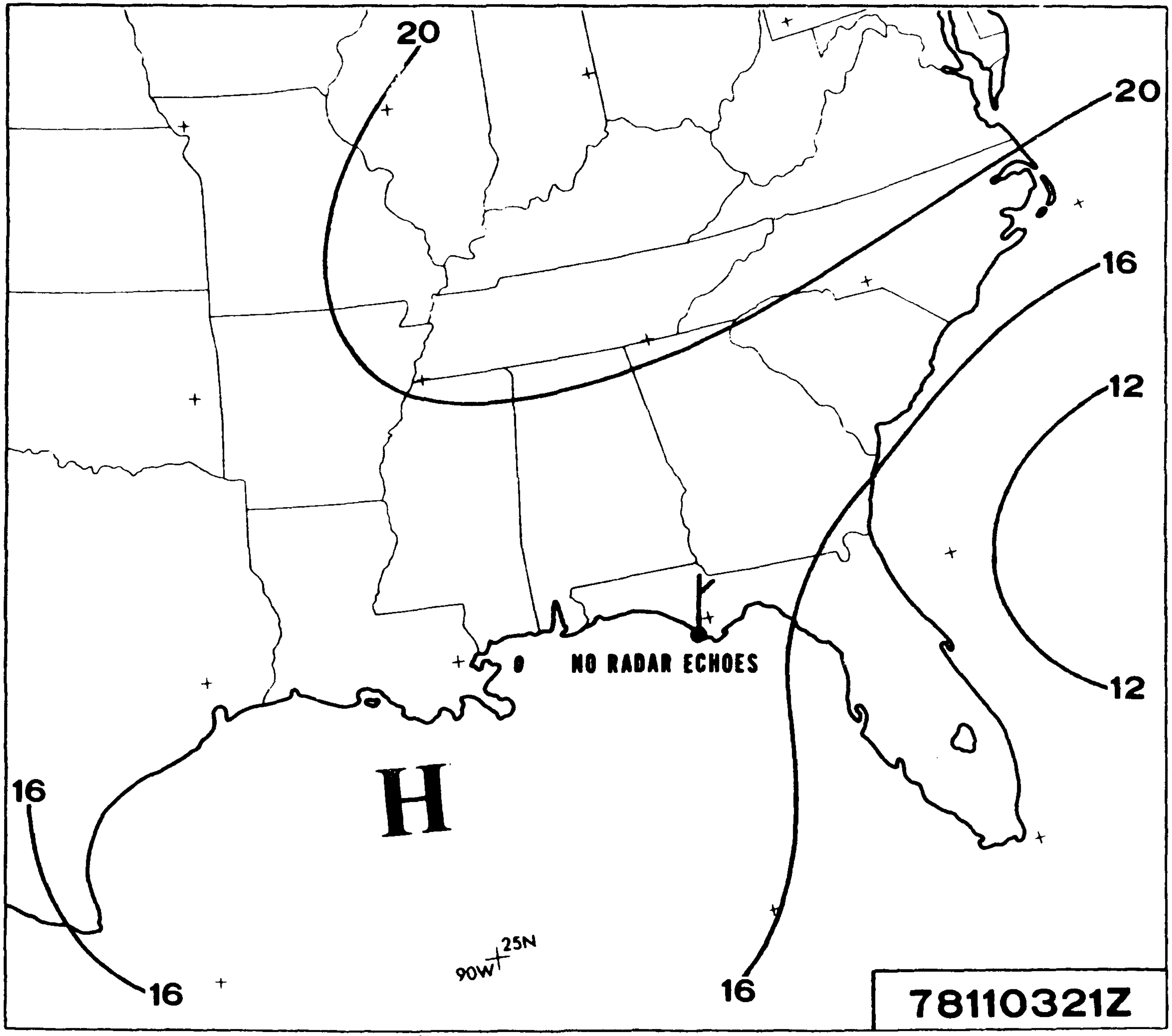


Figure 2-4 78110321Z Synoptic Chart

Table 2-1. Case 2, Apalachicola Surface Weather, 03 Nov 78, 0200Z - 03 Nov 78, 1800Z.

Date-Time (1978) (Z)	Temperature (^oC)	Dew-Point Depression (^oC)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 03 00	16.1	2.8	CALM	CALM	CLR	5	H
03	13.3	0.5	CALM	CALM	CLR	6	H
06	13.9	1.7	CALM	CALM	CLR	5	F K
09	11.7	1.1	CALM	CALM	CLR	6	F
12	11.7	1.1	10	4	CLR	4	F
15	20.6	10.0	--	--	CLR	7	None
18	25.6	17.8	40	12	CLR	7	None
21	25.6	18.4	50	7	CLR	6	H

Table 2-2. Case 2, Tyndall Surface Weather, 03 Nov 78, 0200Z - 03 Nov 78, 1800Z.

Date-Time (1978) (Z)	Temperature (^oC)	Dew-Point Depression (^oC)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 03 00	19.4	5.5	CALM	CALM	SCT	7	None
03	18.3	4.4	CALM	CALM	CLR	7	None
06	13.9	5.0	CALM	CALM	CLR	7	None
09	15.0	7.8	330	3	CLR	7	None
12	12.8	6.1	CALM	CALM	CLR	7	None
15	21.1	12.2	30	4	CLR	7	None
18	26.1	18.9	40	5	SCT	7	None
21	24.4	11.6	210	6	CLR	6	H

Table 2-3. Case 2, Eglin Surface Weather, 03 Nov 78, 0200Z - 03 Nov 78, 1800Z.

Date-Time (1978) (Z)	Temperature (^oC)	Dew-Point Depression (^oC)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 03 00	21.7	14.5	CALM	CALM	SCT	7	None
03	18.3	11.1	CALM	CALM	SCT	7	None
06	17.2	9.4	CALM	CALM	CLR	8	None
09	15.0	6.7	330	2	CLR	8	None
12	13.3	5.5	360	2	SCT	6	F
15	21.1	11.7	350	4	CLR	7	None
18	27.8	20.6	330	7	SCT	7	None
21	26.1	15.0	320	8	CLR	7	None

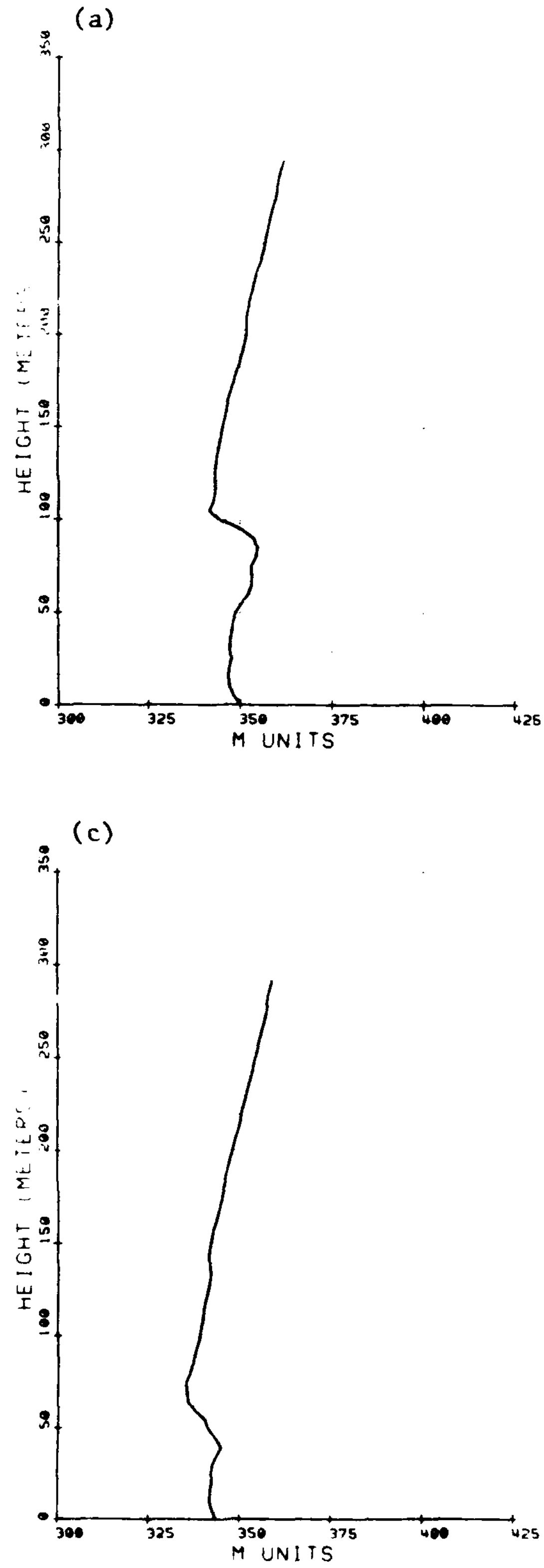


Figure 2-5 Case 2 M-Profiles: a. Cape San Blas, 3 Nov 78, 1000Z; b. Cape San Blas, 3 Nov 78, 1200Z; c. Cape San Blas, 3 Nov 78, 1400Z; d. Cape San Blas, 3 Nov 78, 1600Z.

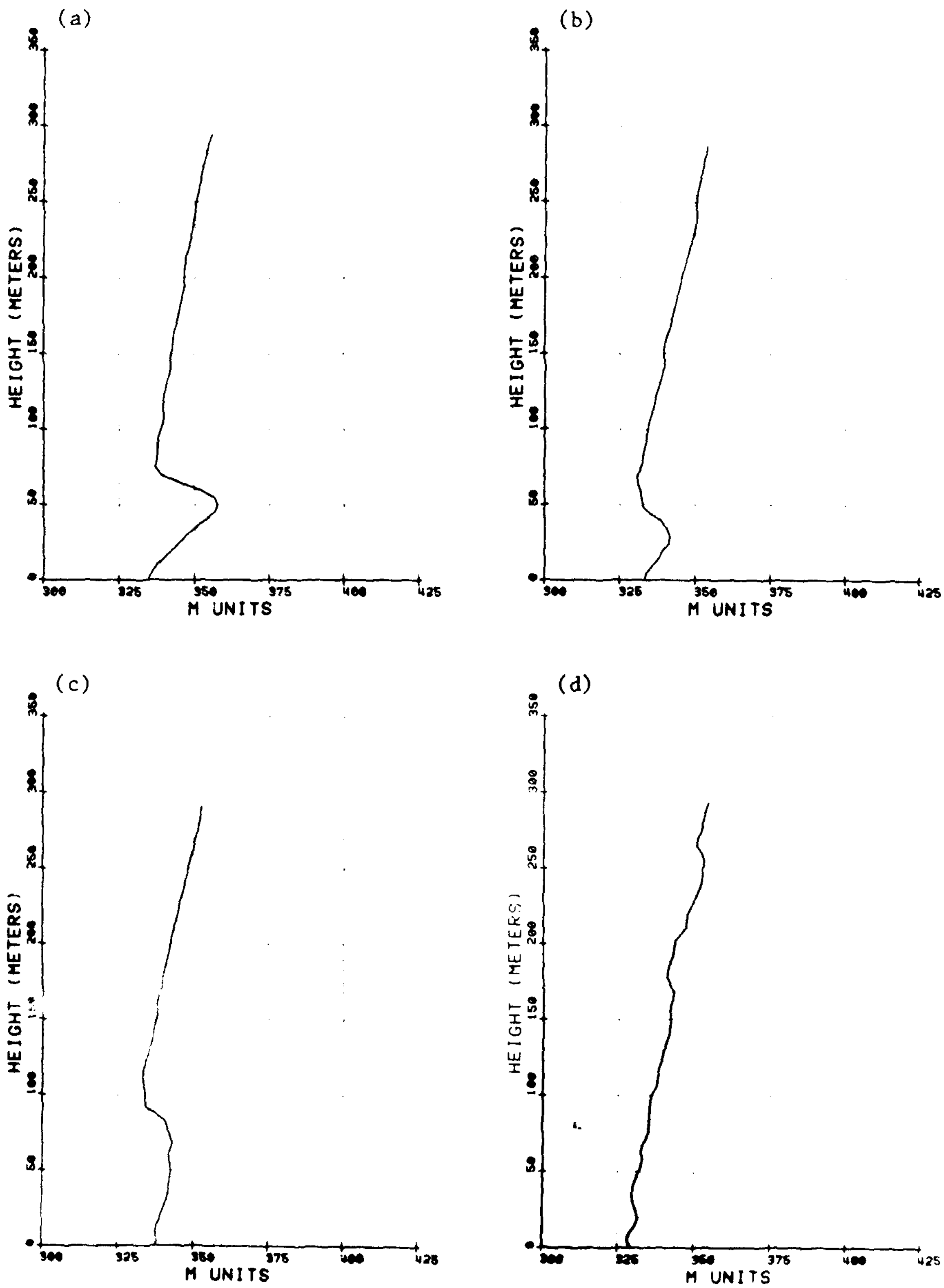


Figure 2-6 Case 2 M-Profiles: a. White City, 3 Nov 78, 0800Z; b. White City, 3 Nov 78, 1200Z; c. White City, 3 Nov 78, 1400Z; d. White City, 3 Nov 78, 1600Z.

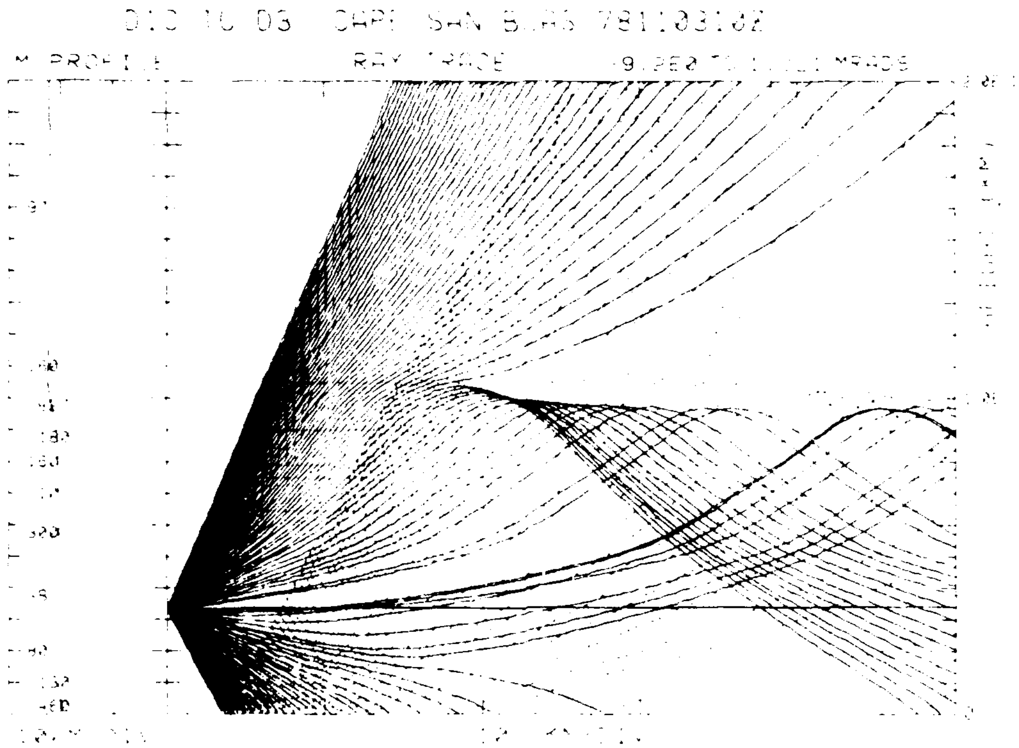


Figure 2-7. Case 2 Raytrace, D1C to D3, Cape San Blas, 3 Nov 78, 1000Z, Transmitter Height 33.5 m.

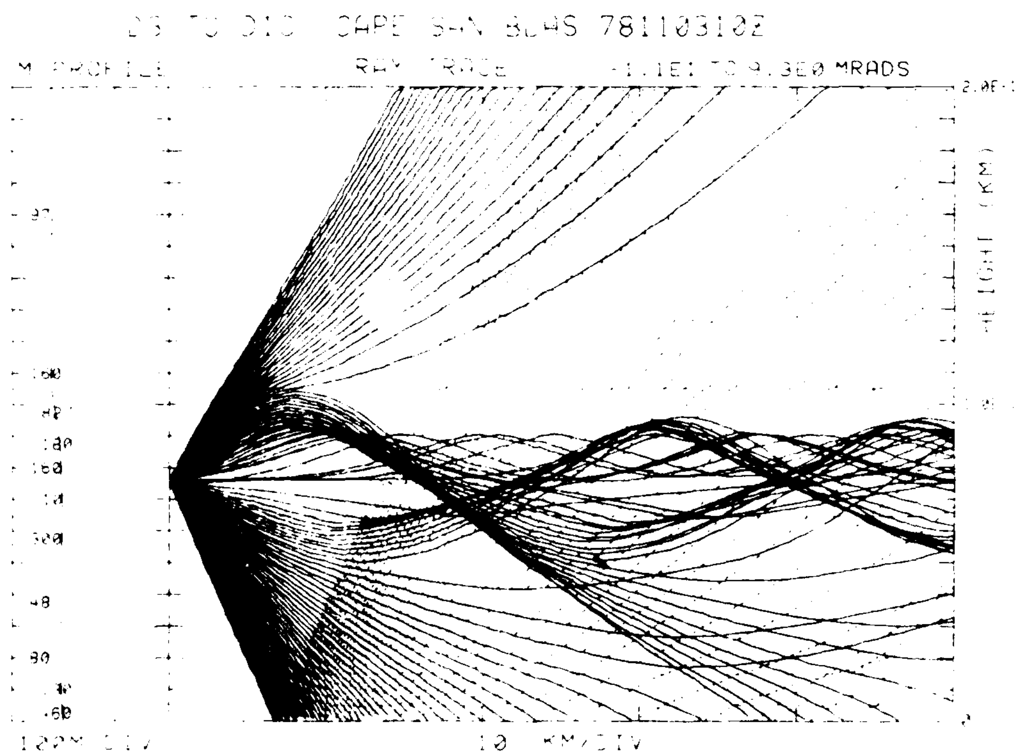


Figure 2-8. Case 2 Raytrace, D3 to D1C, Cape San Blas, 3 Nov 78, 1000Z, Transmitter Height 76.2 m.

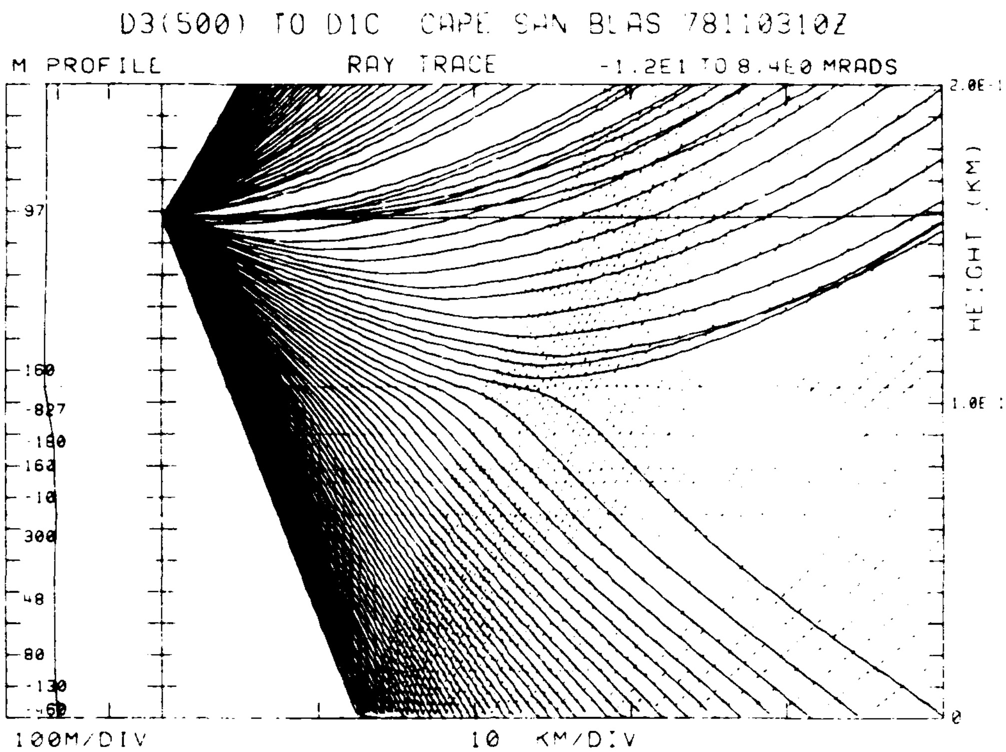


Figure 2-9 . **Case 2 Raytrace, D3(500) to D1C, Cape San Blas 3 Nov 78, 1000Z, Transmitter Height 158.4 m.**

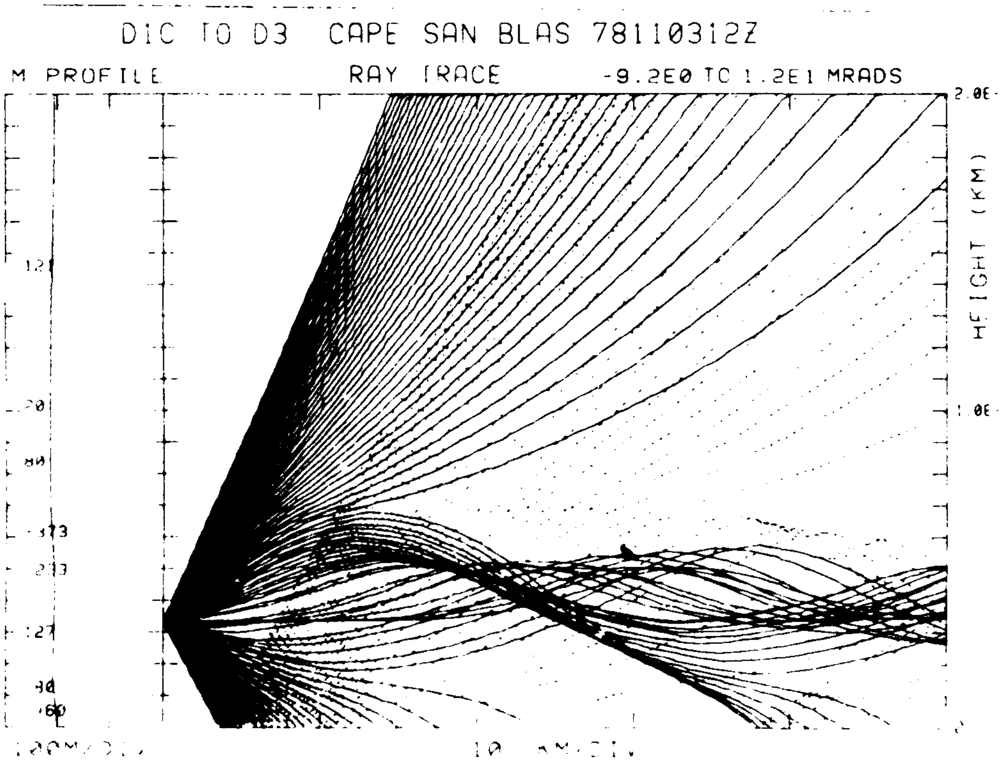


Figure 2-10. **Case 2 Raytrace, D1C to D3. Cape San Blas, 3 Nov 78, 1200Z. Transmitter Height 33.5 m.**

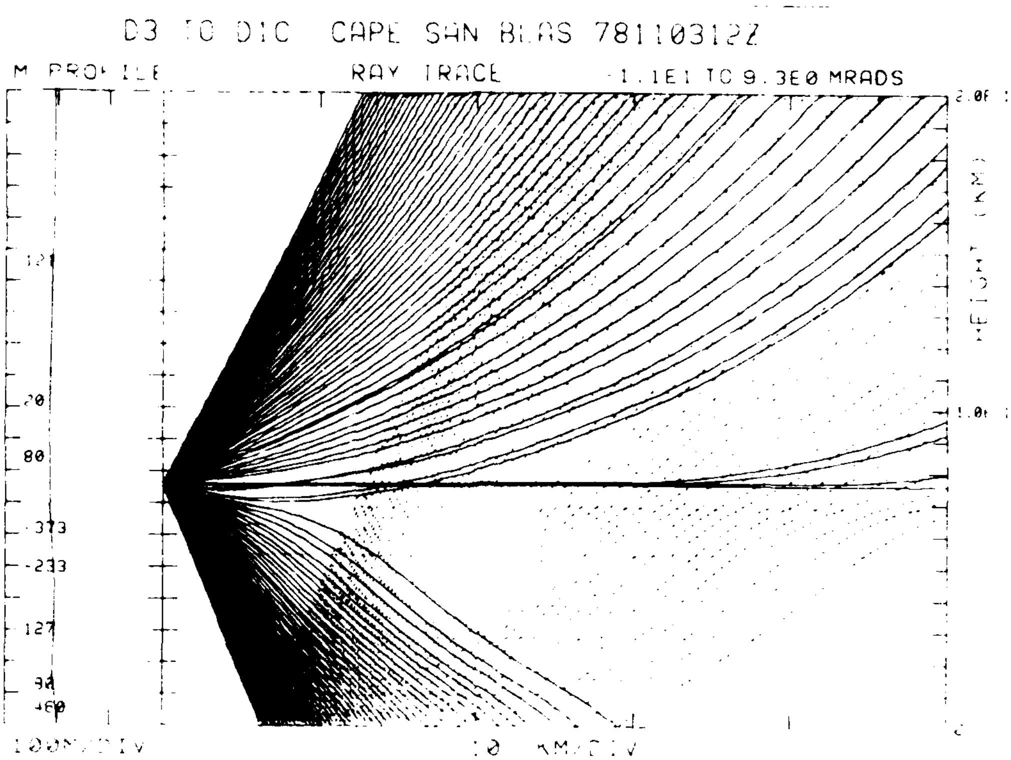


Figure 2-11 . Case 2 Raytrace, D3 to DlC, Cape San Blas, 3 Nov 78, 1200Z, Transmitter Height 76.2 m.

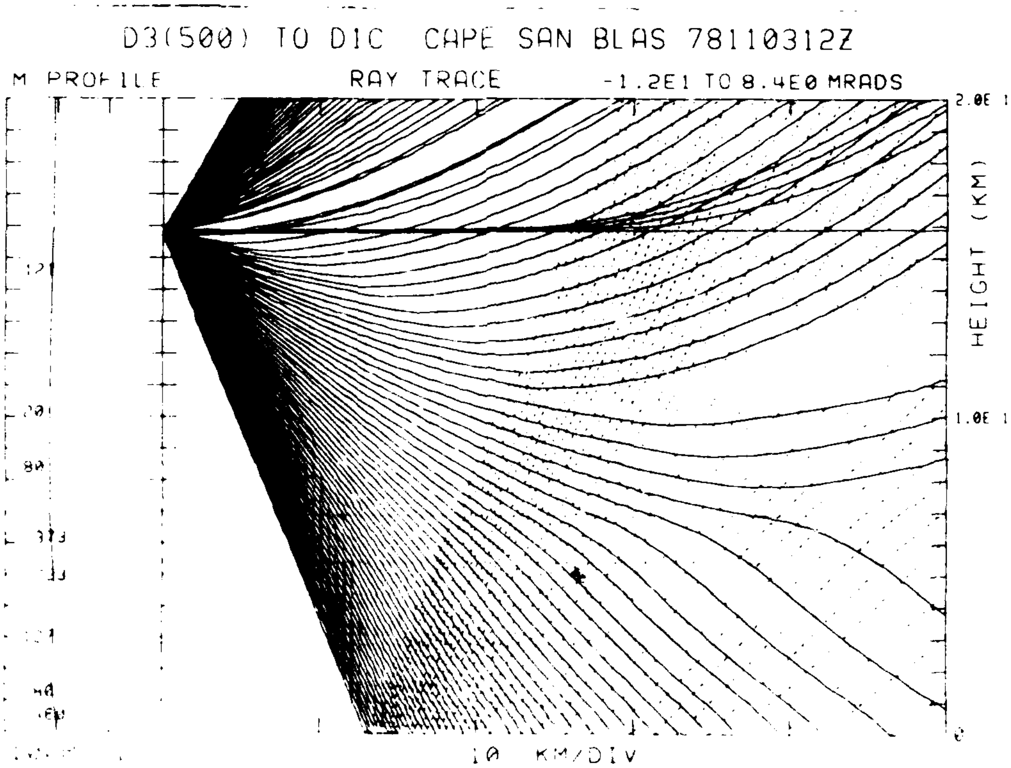


Figure 2-12 . Case 2 Raytrace, D3(500) to DlC, Cape San Blas 3 Nov 78, 1200Z, Transmitter Height 158.4 m.

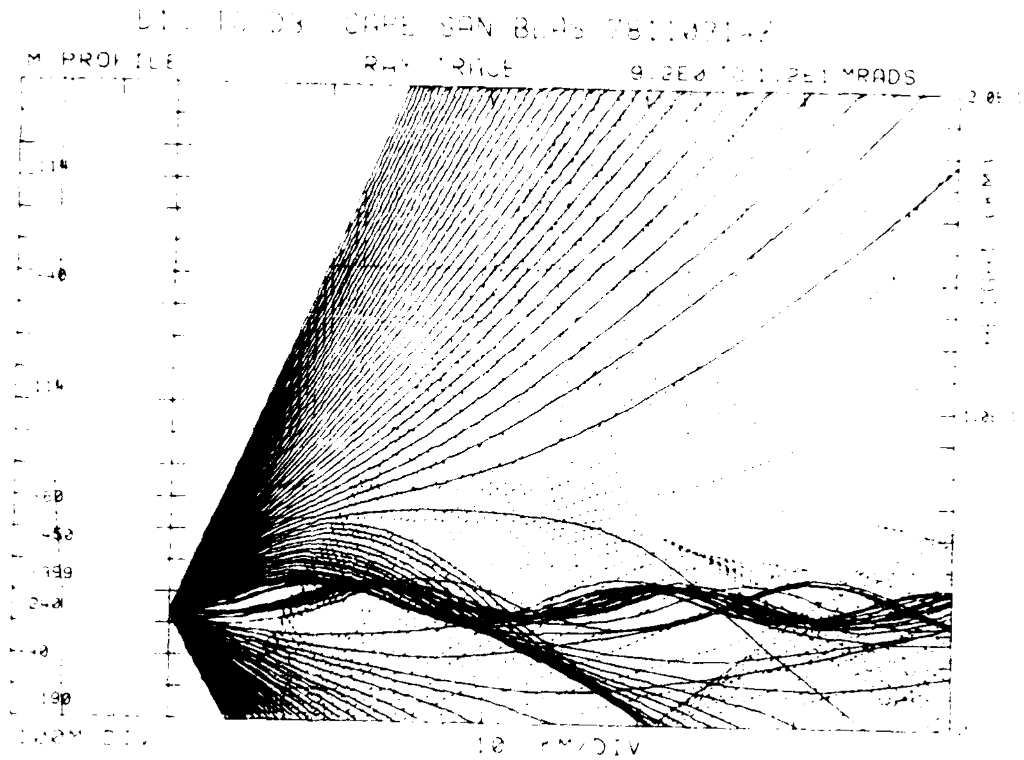


Figure 2-13· Case 2 Raytrace, DlC to D3, Cape San Blas, 3 Nov 78, 1400Z, Transmitter Height 33.5 m.

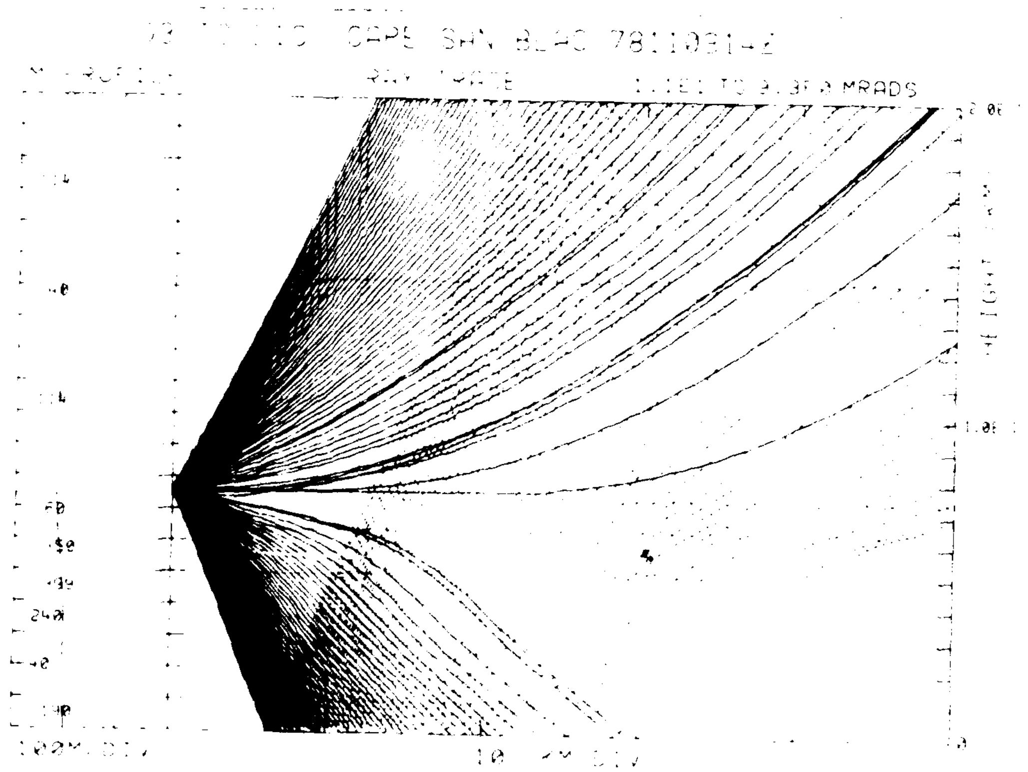


Figure 2-14 · Case 2 Raytrace, D3 to DlC, Cape San Blas, 3 Nov 78, 1400Z, Transmitter Height 76.2 m.

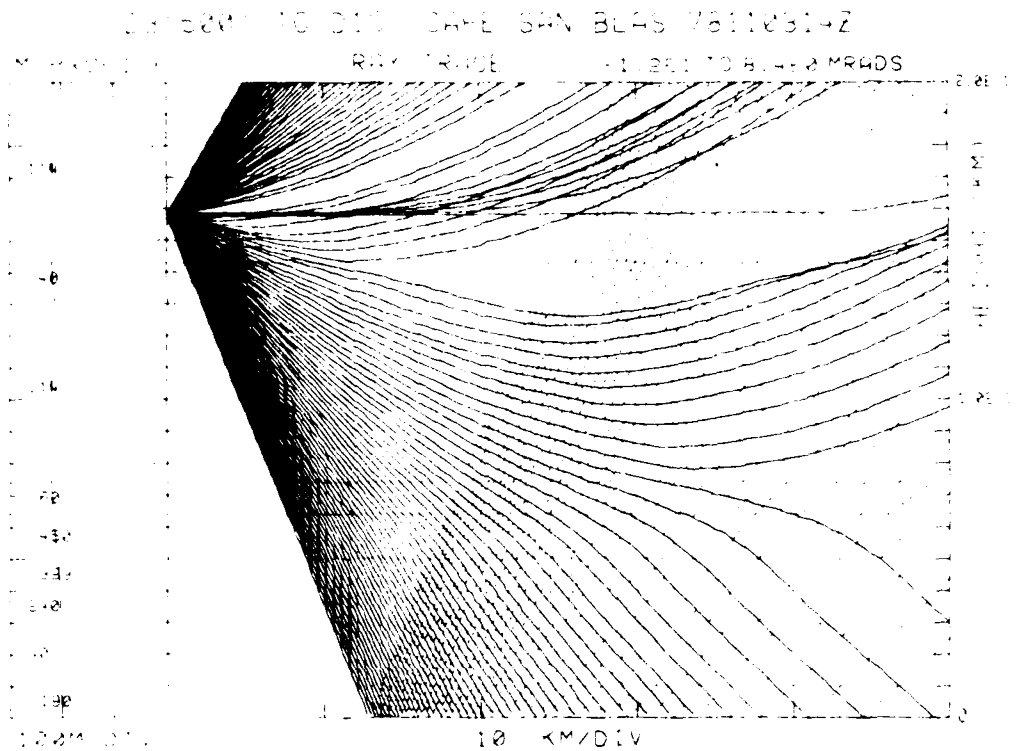


Figure 2-15. Case 2 Raytrace, D3(500) to DIC, Cape San Blas 3 Nov 78, 1400Z, Transmitter Height 158.4 m.

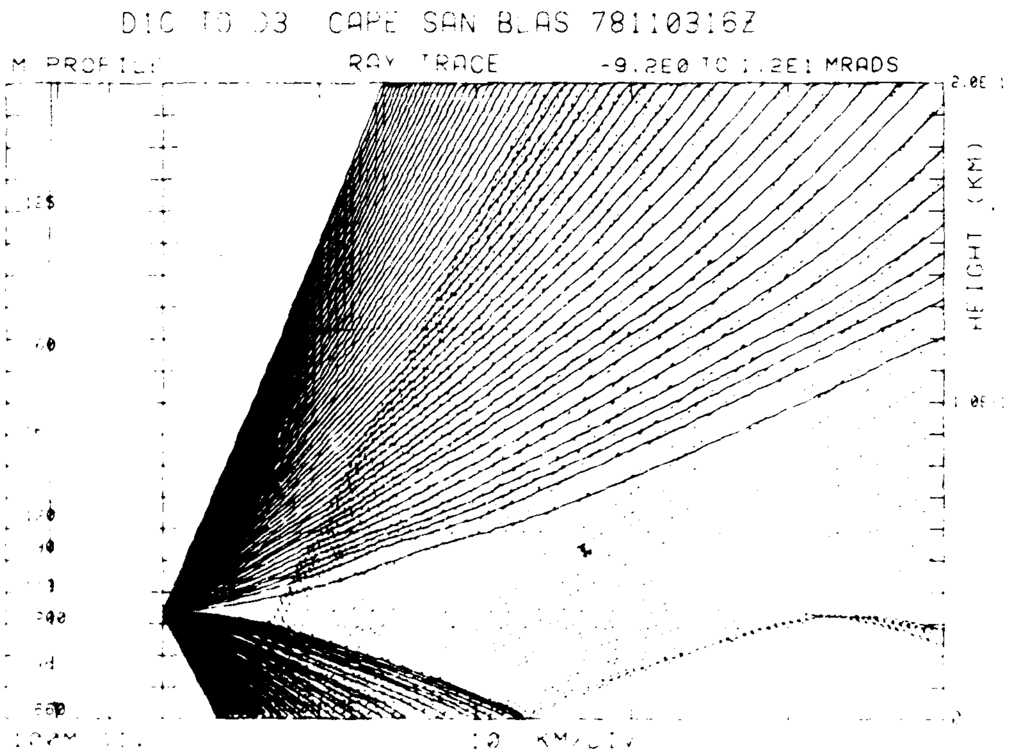


Figure 2-16. Case 2 Raytrace, DIC to D3, Cape San Blas, 3 Nov 78, 1600Z, Transmitter Height 33.5 m.

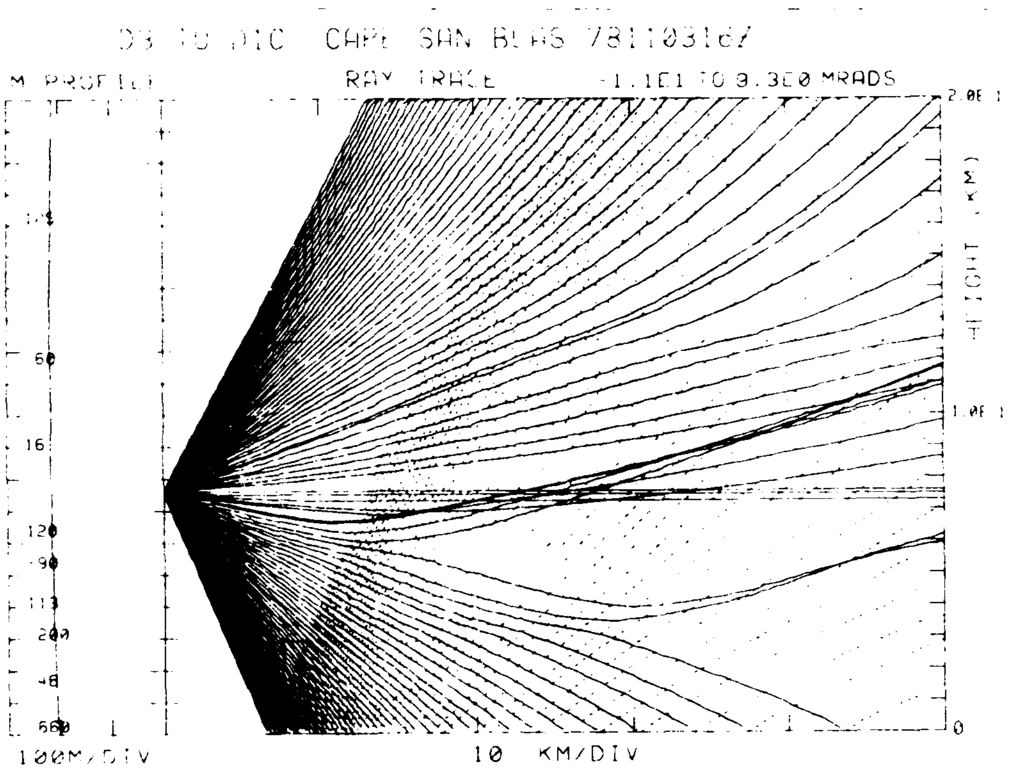


Figure 2-17. Case 2 Raytrace, D3 to DIC, Cape San Blas, 3 Nov 78, 1600Z, Transmitter Height 76.2 m.

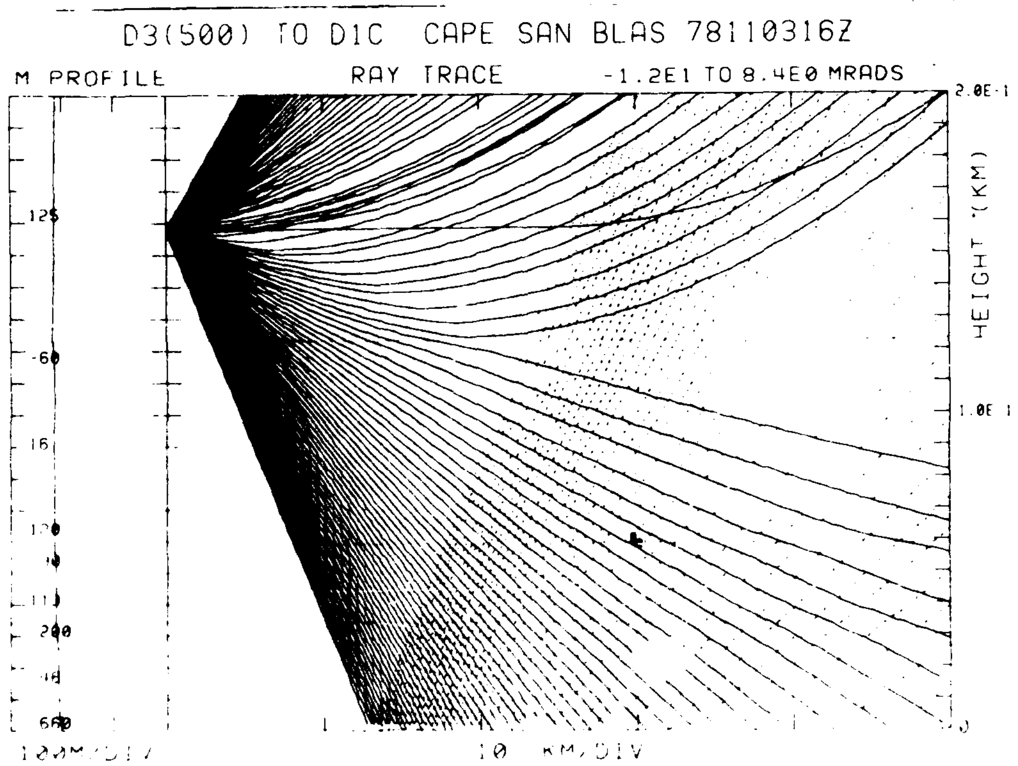


Figure 2-18. Case 2 Raytrace, D3(500) to DIC, Cape San Blas 3 Nov 78, 1600Z, Transmitter Height 158.4 m.

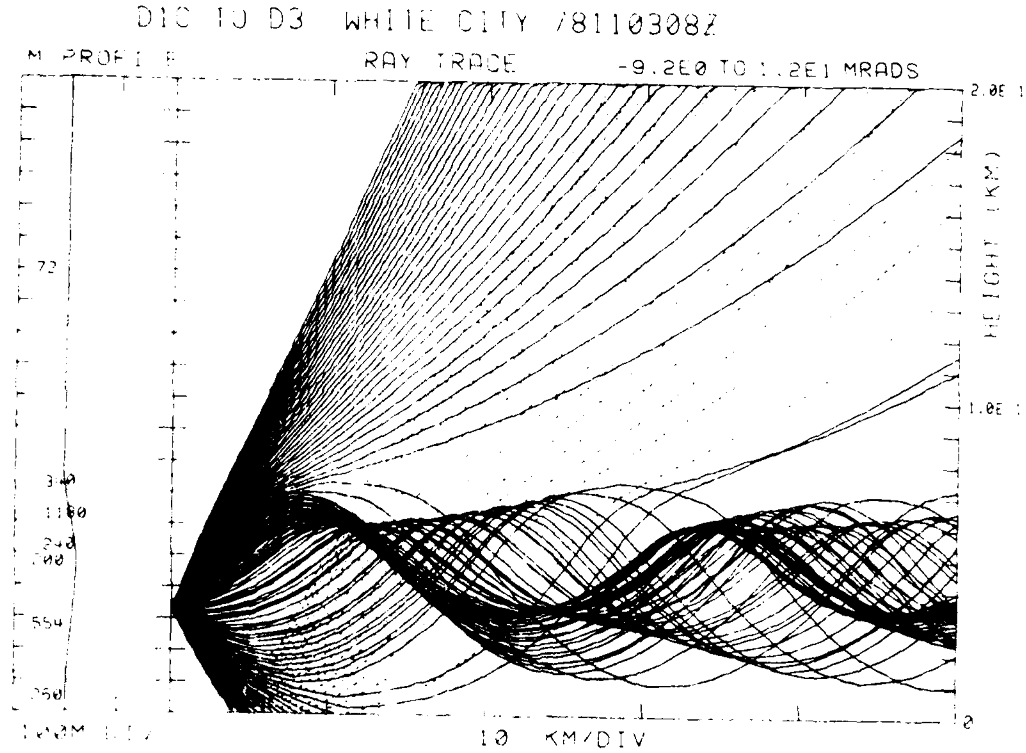


Figure 2-19. Case 2 Raytrace, D1C to D3, White City, 3 Nov 78, 0800Z, Transmitter Height 33.5 m.

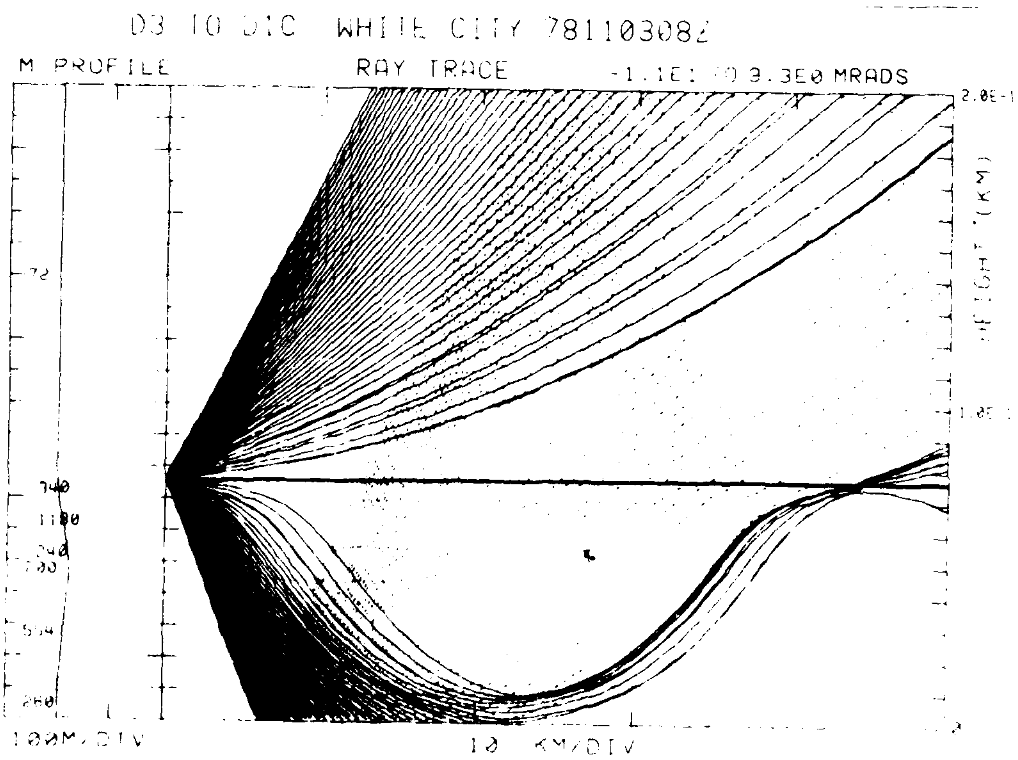


Figure 2-20. Case 2 Raytrace, D3 to D1C, White City, 3 Nov 78, 0800Z, Transmitter Height 76.2 m.

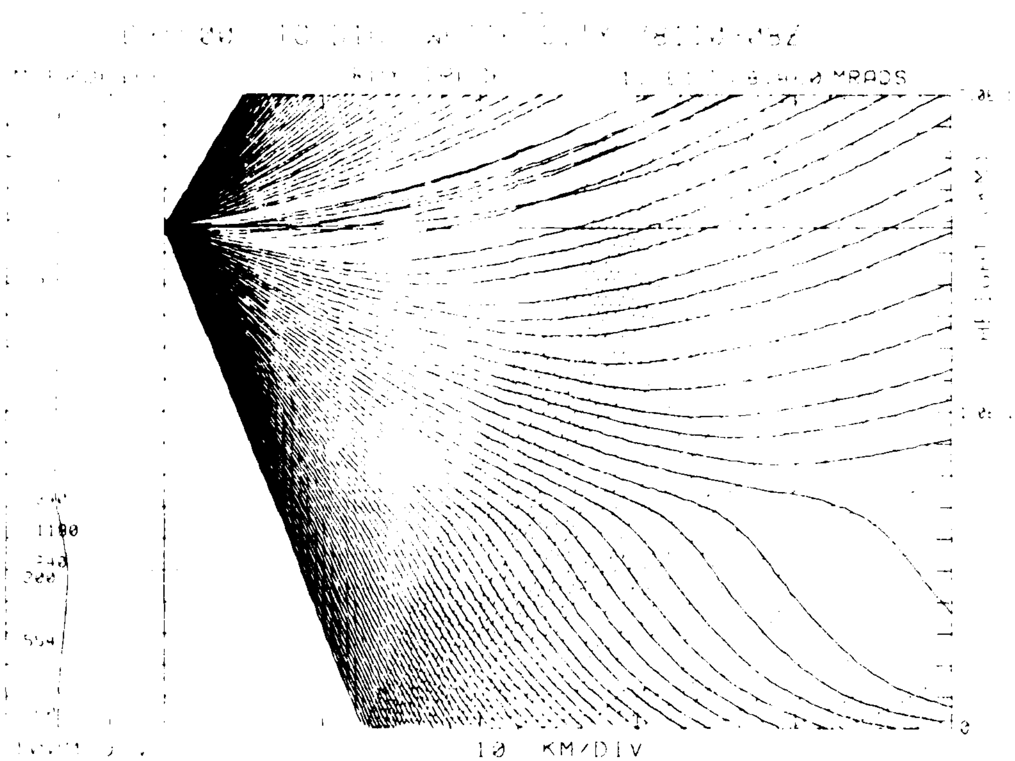


Figure 2-21. Case 2 Raytrace, D3(500) to D1C, White City 3 Nov 78, 0800Z, Transmitter Height 158.4 m.

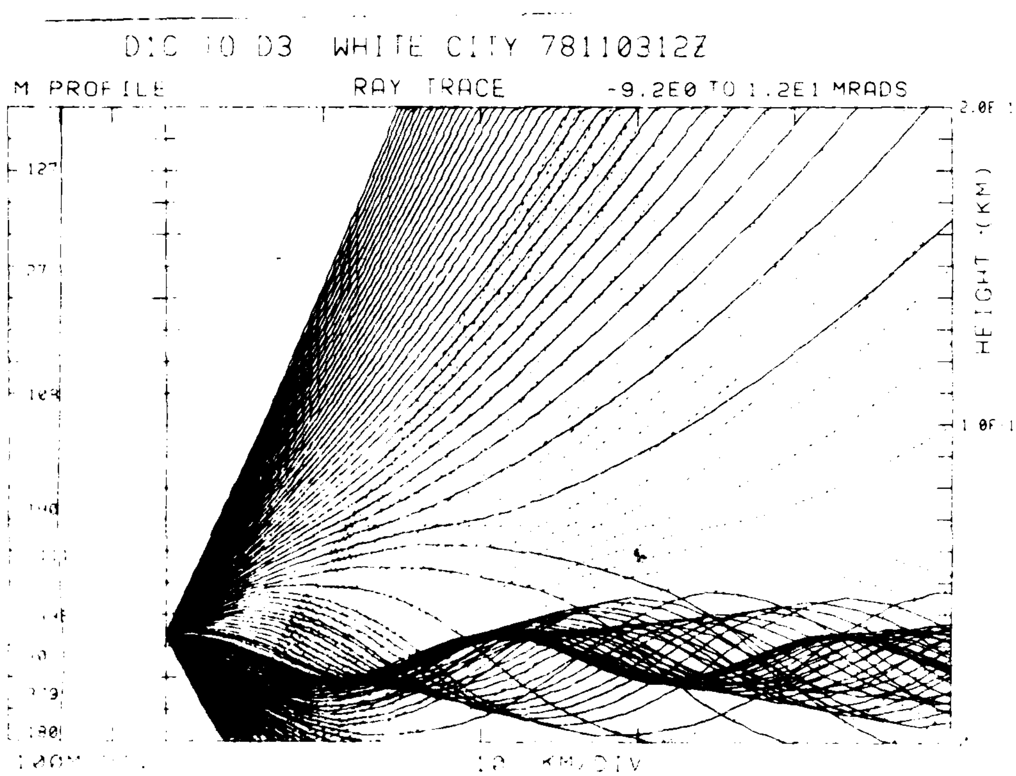


Figure 2-22. Case 2 Raytrace, D1C to D3, White City, 3 Nov 78, 1200Z, Transmitter Height 33.5 m.

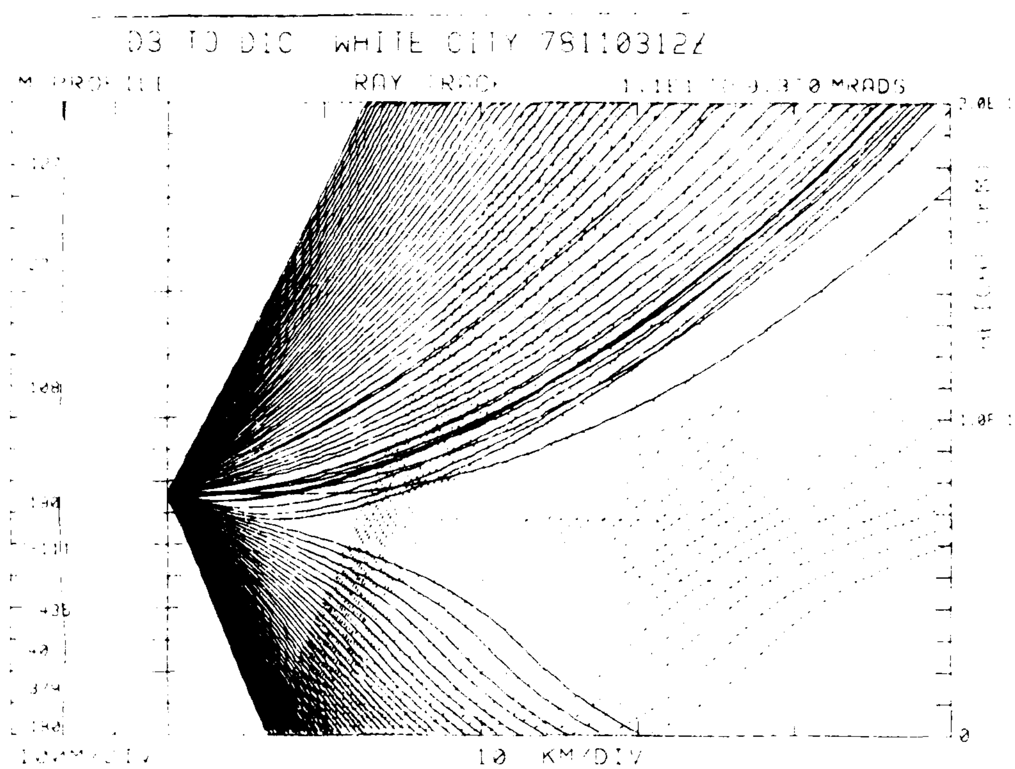


Figure 2-23. Case 2 Raytrace, D3 to D1C, White City, 3 Nov 78, 1200Z, Transmitter Height 76.2 m.

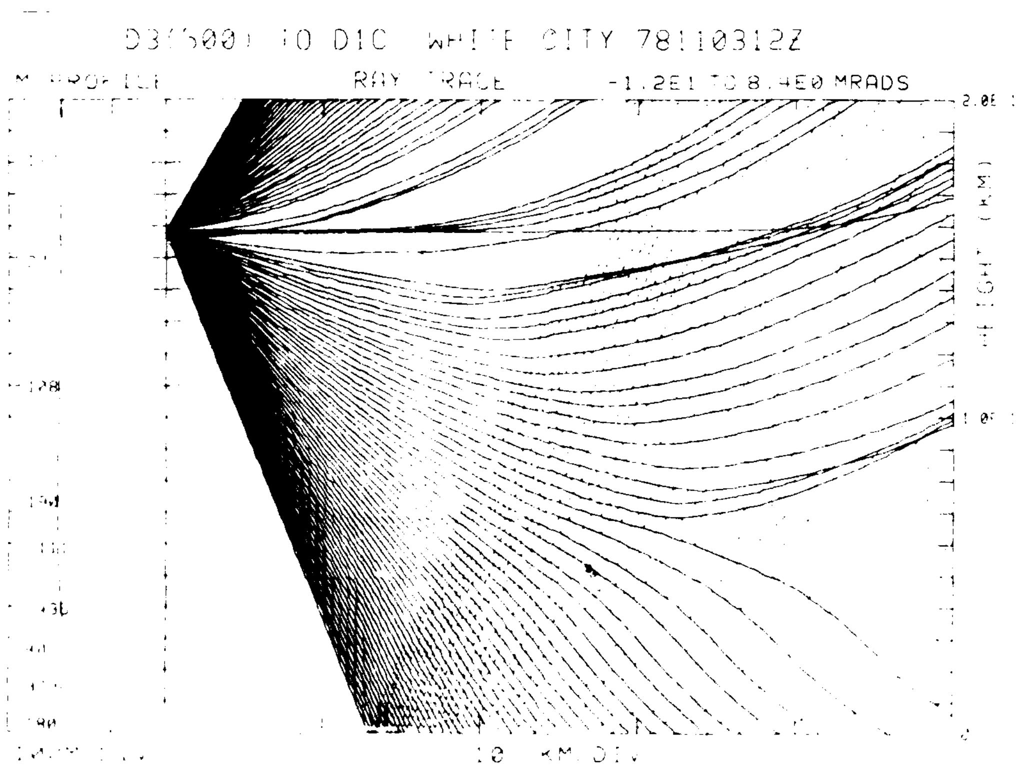


Figure 2-24. Case 2 Raytrace, D3(500) to D1C, White City 3 Nov 78, 1200Z, Transmitter Height 158.4 m.

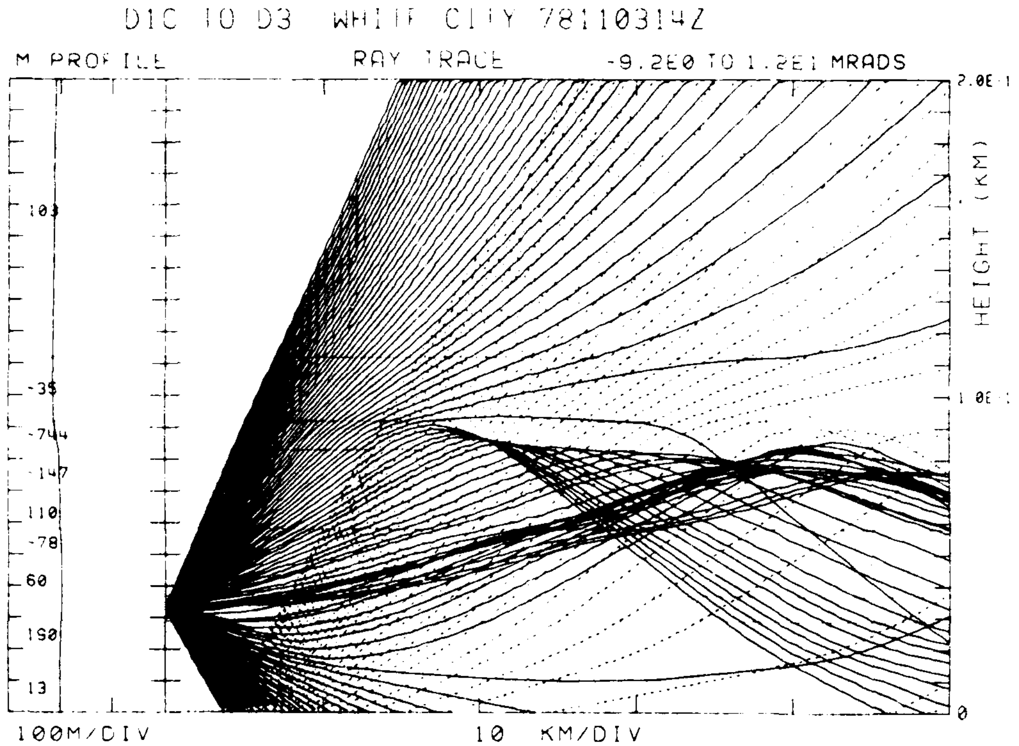


Figure 2-25. Case 2 Raytrace, D1C to D3, White City, 3 Nov 78, 1400Z, Transmitter Height 33.5 m.

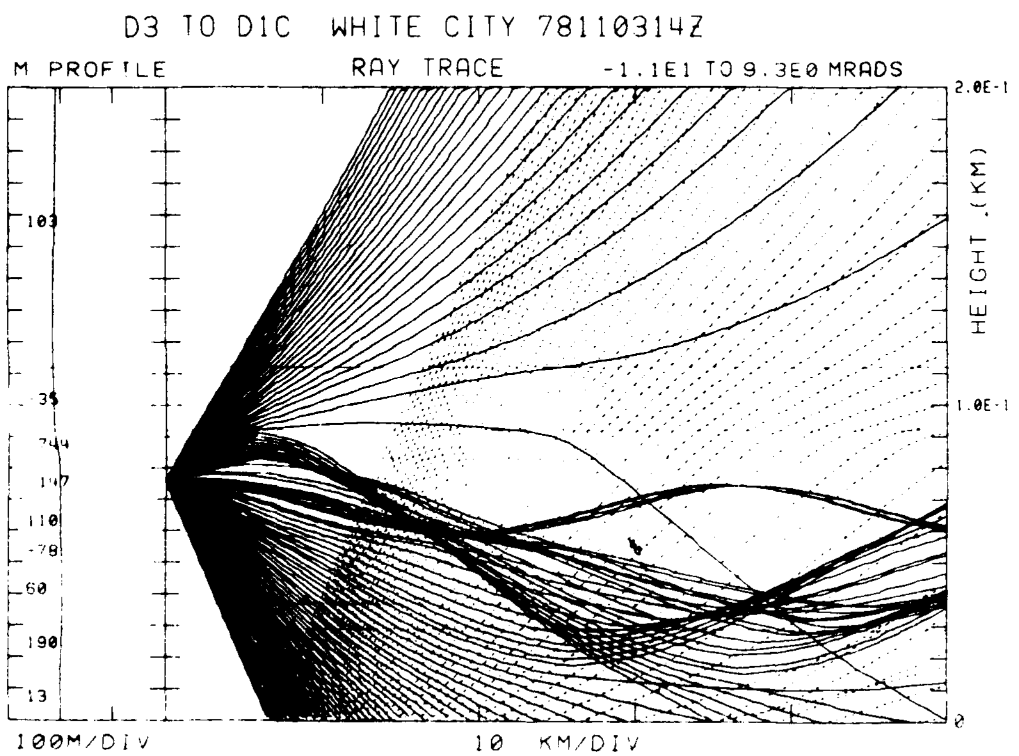


Figure 2-26. Case 2 Raytrace, D3 to D1C, White City, 3 Nov 78, 1400Z, Transmitter Height 76.2 m.

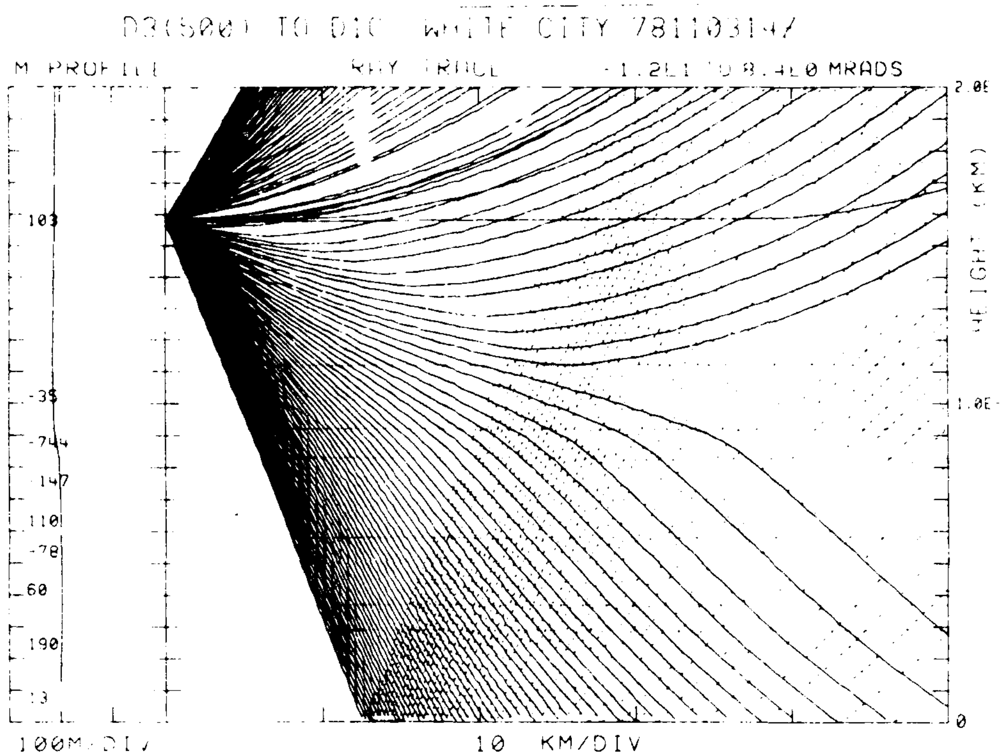


Figure 2-27. Case 2 Raytrace, D3(500) to D1C, White City 3 Nov 78, 1400Z, Transmitter Height 158.4 m.

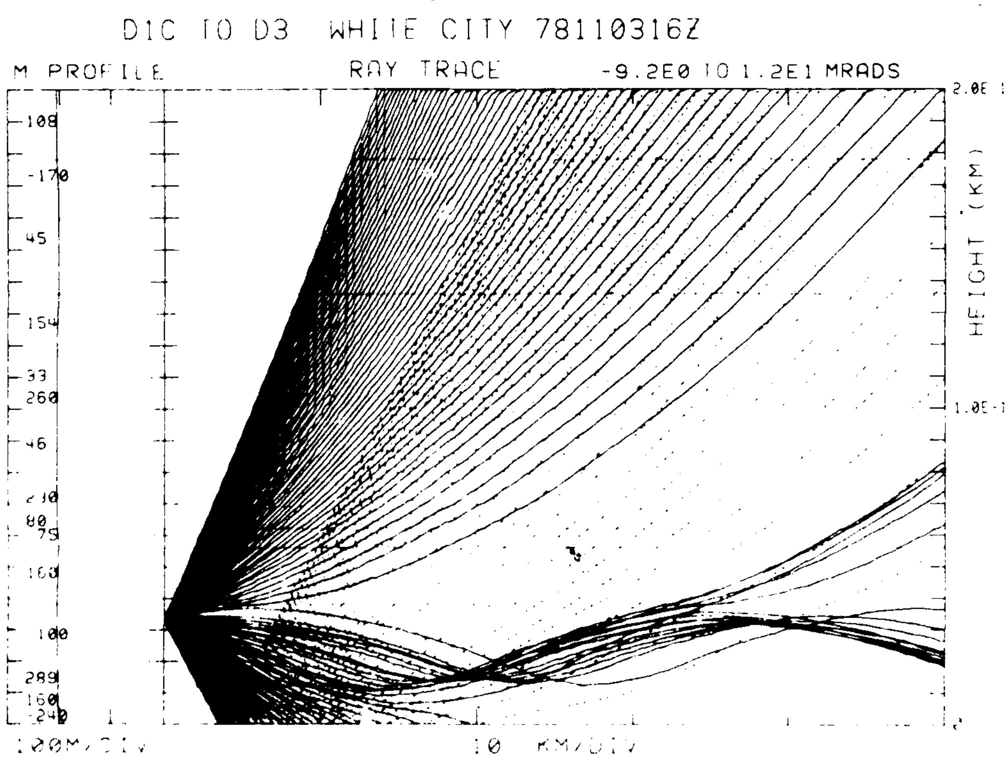


Figure 2-28. Case 2 Raytrace, D1C to D3, White City, 3 Nov 78, 1600Z, Transmitter Height 33.5 m.

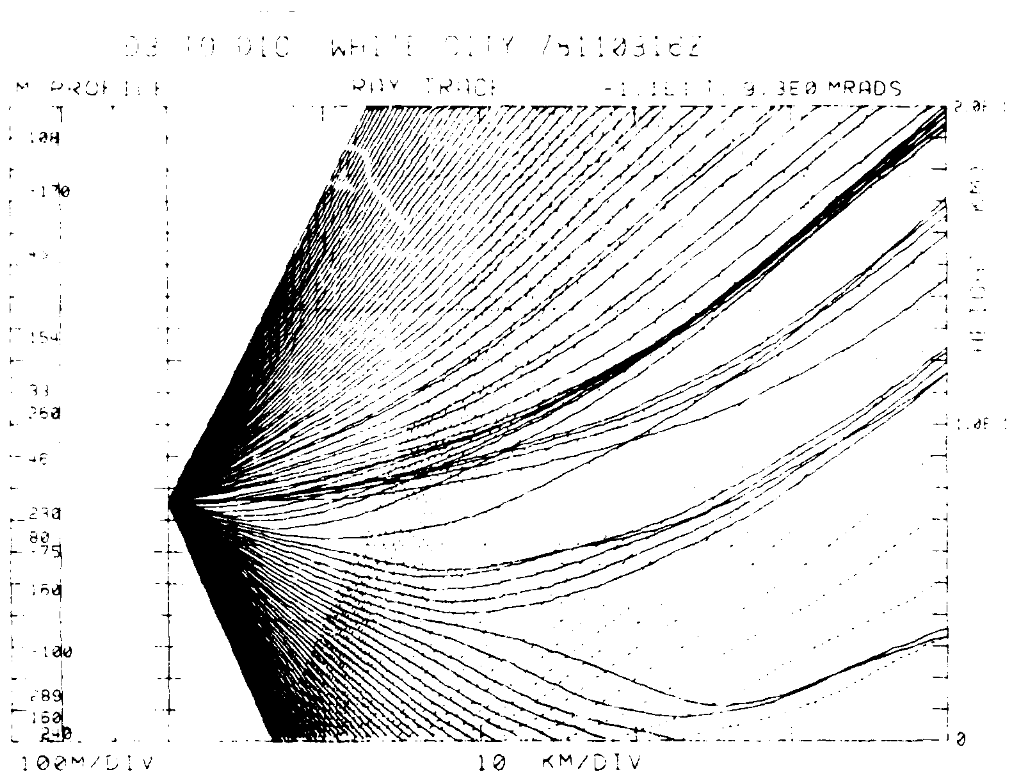


Figure 2-29. Case 2 Raytrace, D3 to D1C, White City, 3 Nov 78, 1600Z, Transmitter Height 76.2 m.

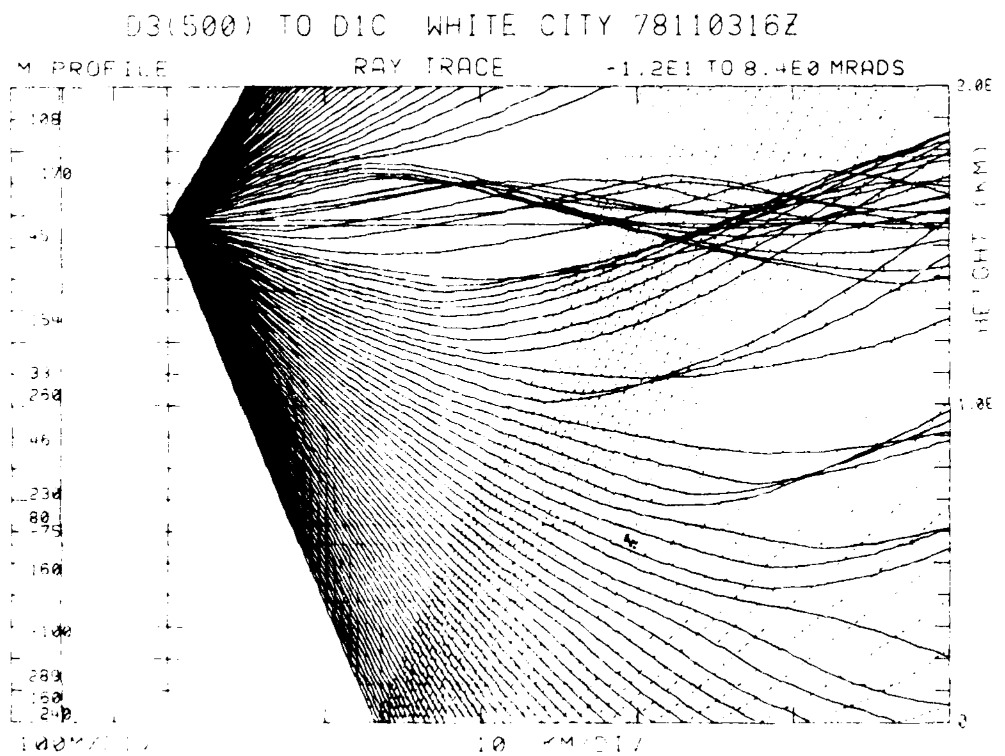


Figure 2-30. Case 2 Raytrace, D3(500) to D1C, White City 3 Nov 78, 1600Z, Transmitter Height 158.4 m.

CASE 3

1. This case (4 November,05-17Z) was judged (by the 1842 EEG) to be one of the worst for RSL conditions of the entire test period. As in Cases 1 and 2, the path is D3-D1C. Figures 3-1 through 3-4 represent the RSL pattern measured at D1C. Here, the signal fluctuates rapidly from above the computed free-space level (-36 dbm) to, in a few instances, below the FM threshold (-80 dbm). Some communications engineers refer to such rapid, large-amplitude fluctuations as "painting." The painting in the figures appears to be superimposed on a slower rolling RSL fluctuation.

2. The synoptic pattern (Figures 3-5 through 3-7) once again indicated a weak pressure gradient, very light northeasterly winds, and no precipitation over the area of interest.

3. The surface observations in Tables 3-1 through 3-3 indicated slight visibility restrictions at Apalachicola and Eglin AFB in the early-morning and a weak sea-breeze formation in the afternoon.

4. The M-profiles shown in Figures 3-8 through 3-10 indicate, as in Case 1, numerous fluctuations in M up to 100-150 meters at Cape San Blas. White City, however, experienced few fluctuations but it did show a more persistent low-level duct.

5. The raytraces for this case (Figures 3-11 through 3-33) differ from all other cases in that the transmission from 158.4 meters at D3 was not routinely employed. Instead, a series of different heights was used with just the Cape San Blas 4 Nov/14Z profile. The figure denoted by D1C to D3A represents transmission from a 80.8 meter MSL (250 feet AGL) D1C antenna to a 76.2 meter MSL (230 feet AGL) D3 antenna. The figure denoted by D1C to D3A represents transmission from a 80.8 meter MSL (250 feet AGL) D1C antenna to a 158.4 meter MSL (500 feet AGL) d3 antenna. The figure denoted by D1C to D3D represents transmission from a 126.5 meter MSL (400 feet AGL) D1C antenna to a 127.9 meter MSL (400 feet AGL) D3 antenna. Finally the figure denoted by D1C to D3E represents transmission from a 96.0 meter MSL (300 feet AGL) D1C antenna to a 97.4 meter MSL (300 feet AGL) D3 antenna. Also, the M-profile computed from the 4 Nov/12Z National Weather Service (NWS) rawinsonde observation from Apalachicola (which was actually launched at 11Z) was used as a comparison for existing antenna heights. Little inference could be drawn from such a comparison, other than that the large ray pattern differences exemplify the sensitivity of this problem to local effects and the resolution of data used.

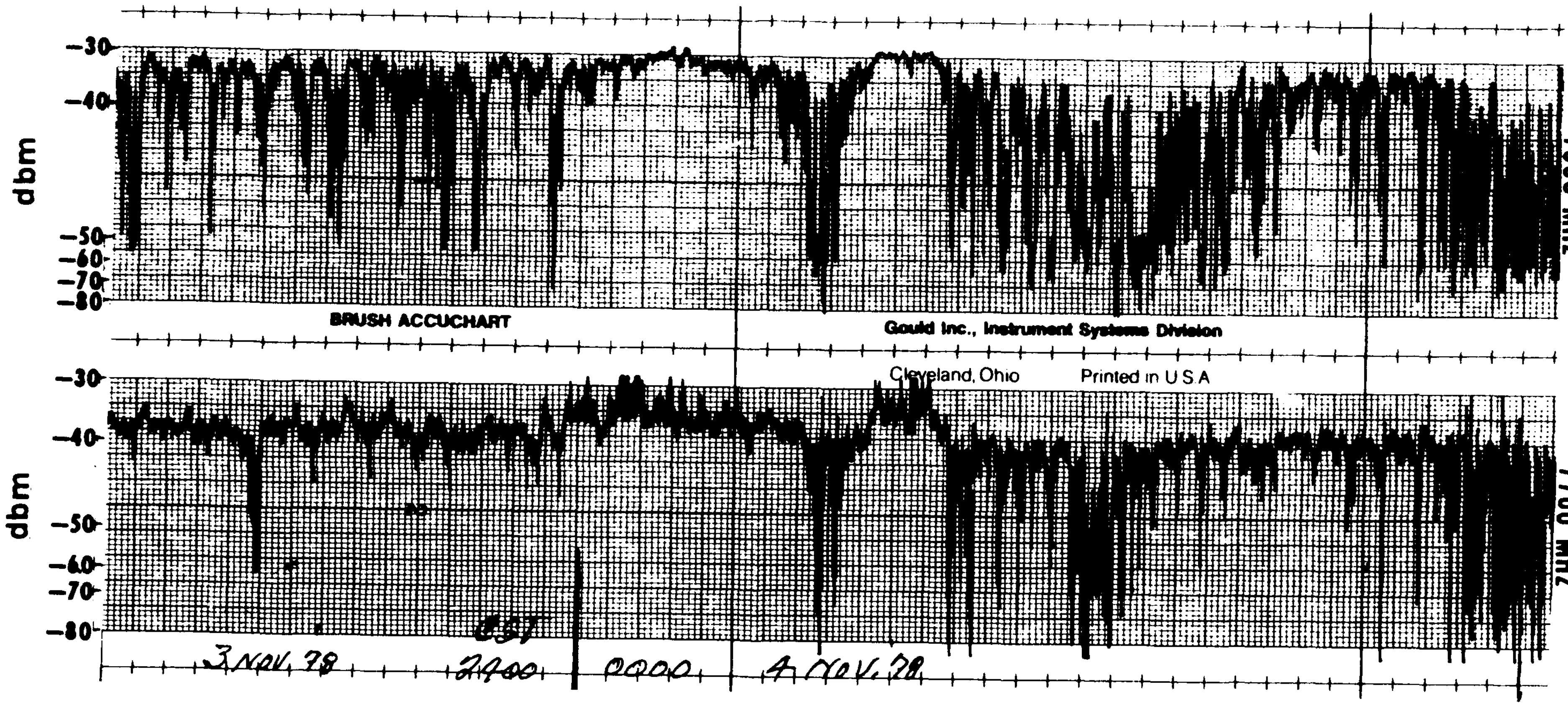


Figure 3-1 Case 3 RSL Strip Chart showing typical fade pattern on both channels of D1C received from D3. Times are from 2345 CST, 3 Nov 78 to 0031 CST, 4 Nov 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

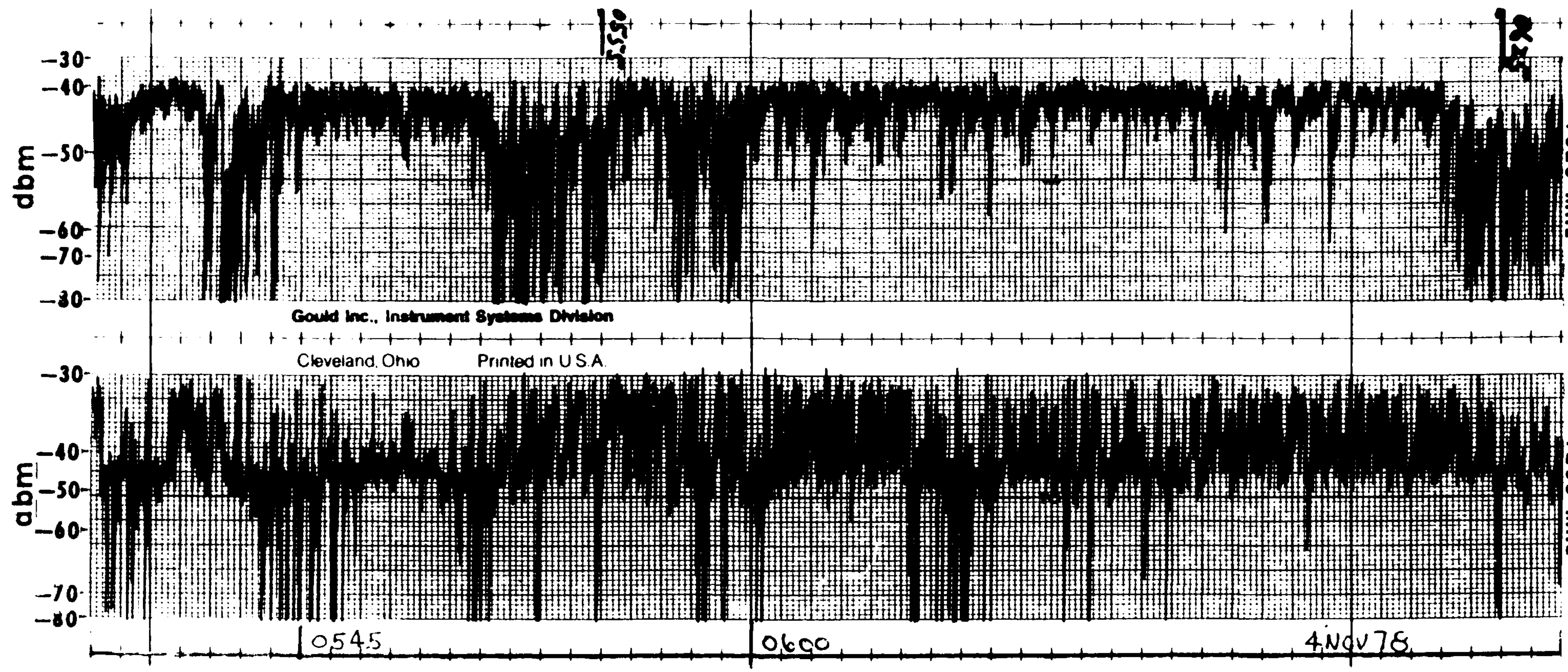


Figure 3-2 Case 3 RSL Strip Chart showing typical fade pattern on both channels of D3 received from DIC. Times are from 0538 EST to 0627 EST, 4 Nov 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

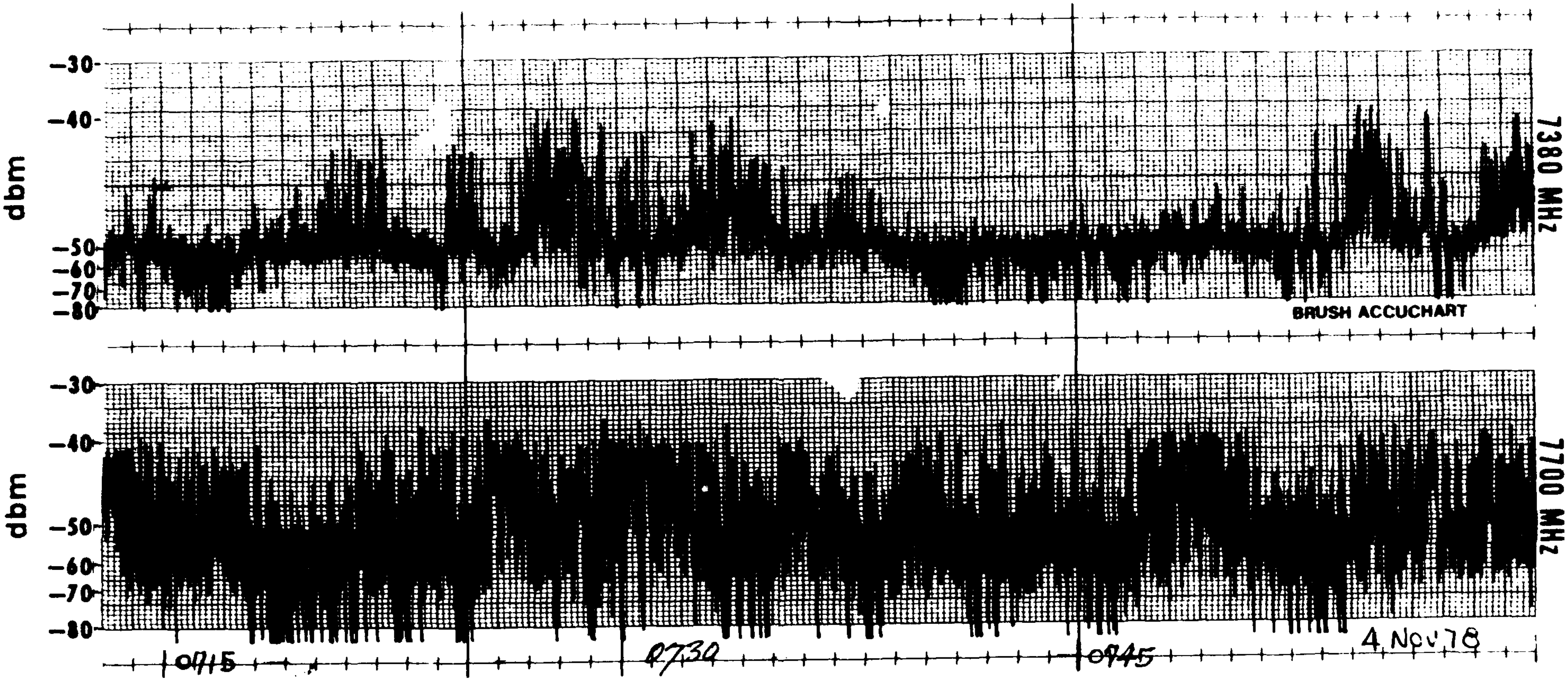


Figure 3-3 Case 3 FSL Strip Chart showing typical fade pattern on both channels of D1C received from D3. Times are from 0713 CST to 0800 CST, 4 Nov 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

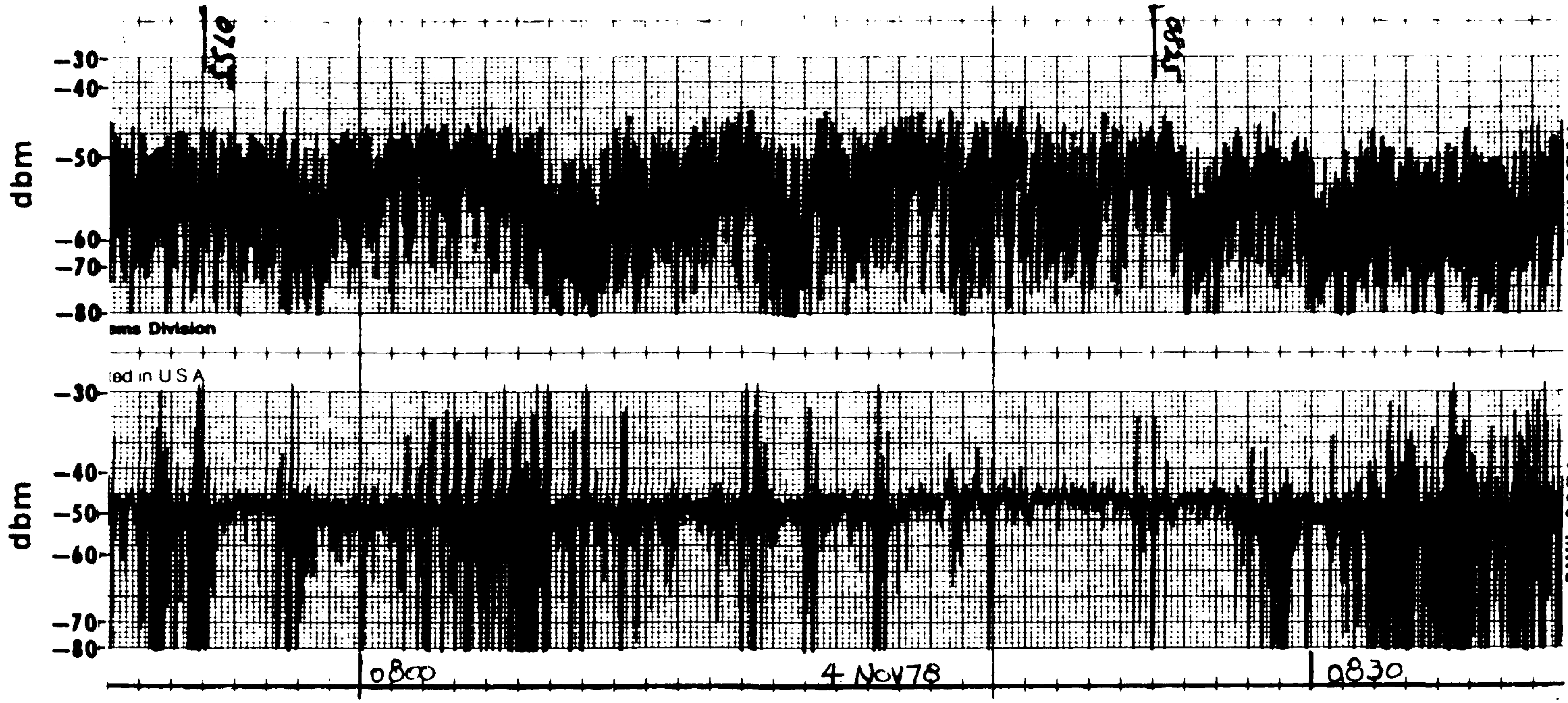


Figure 3-4 Case 3 RSL Strip Chart showing typical fade pattern on both channels of D3 received from DiC. Times are from 0752 EST to 0838 EST, 4 Nov 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

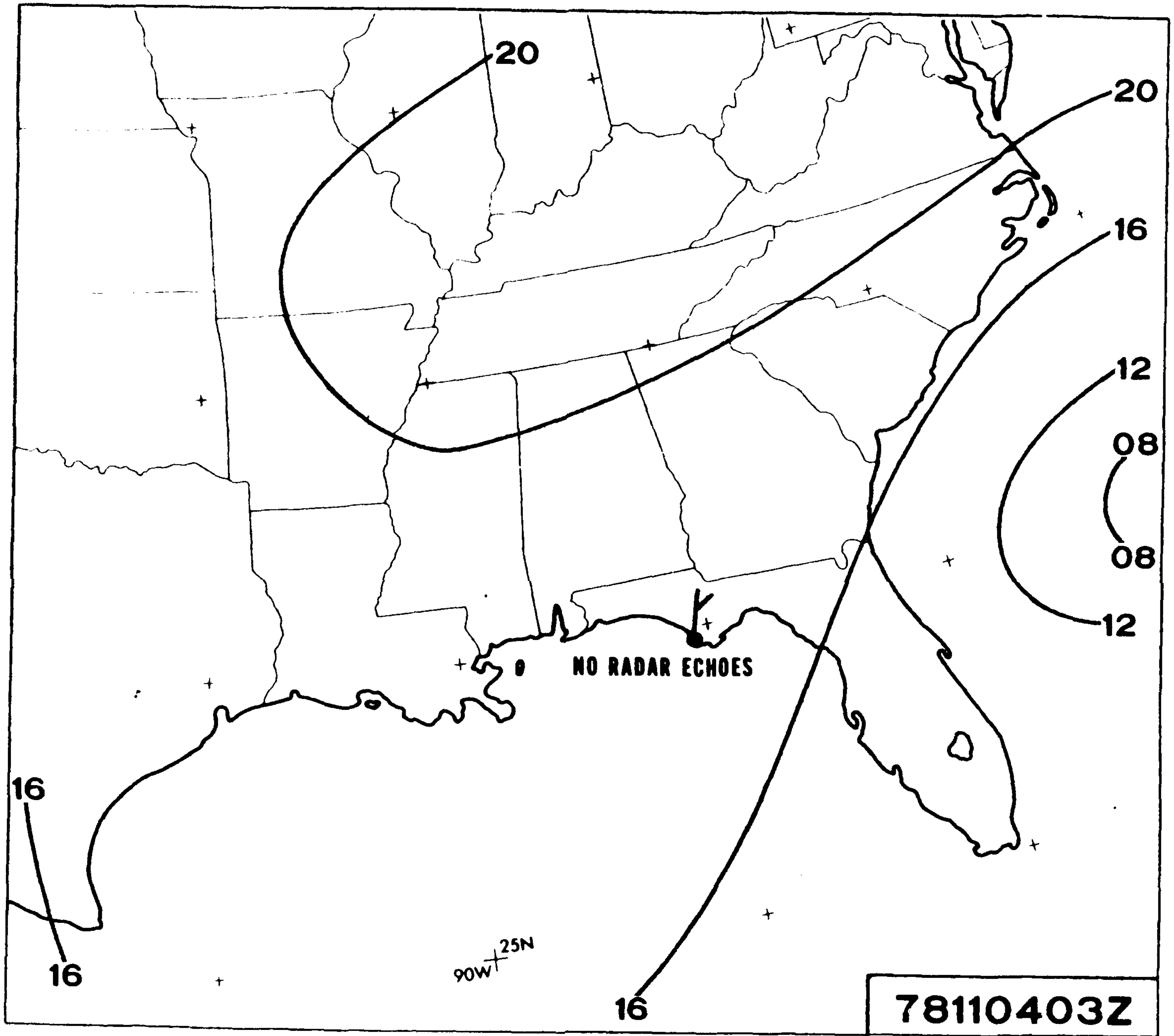


Figure 3-5 78110403Z Synoptic Chart

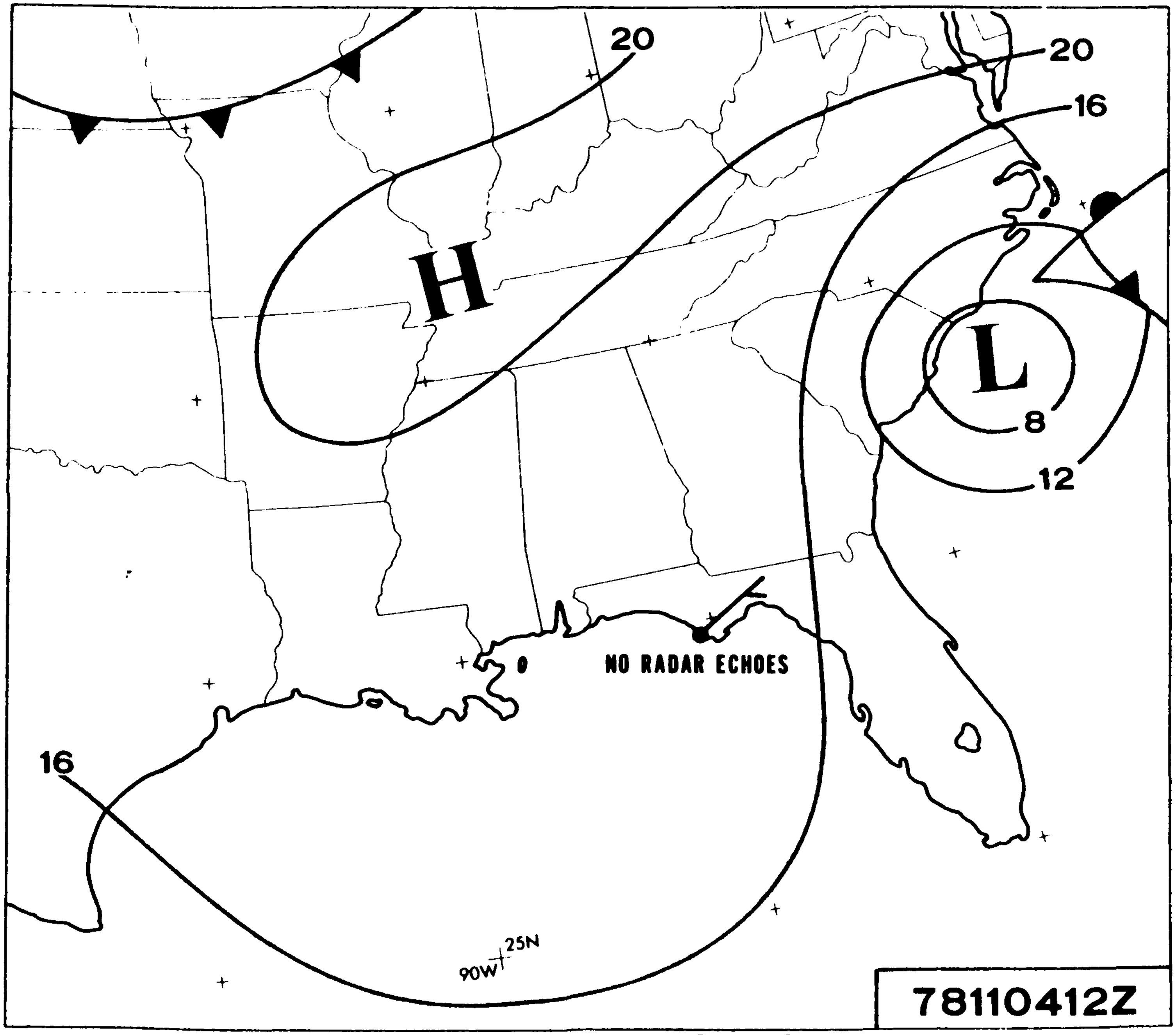


Figure 3-6 78110412Z Synoptic Chart

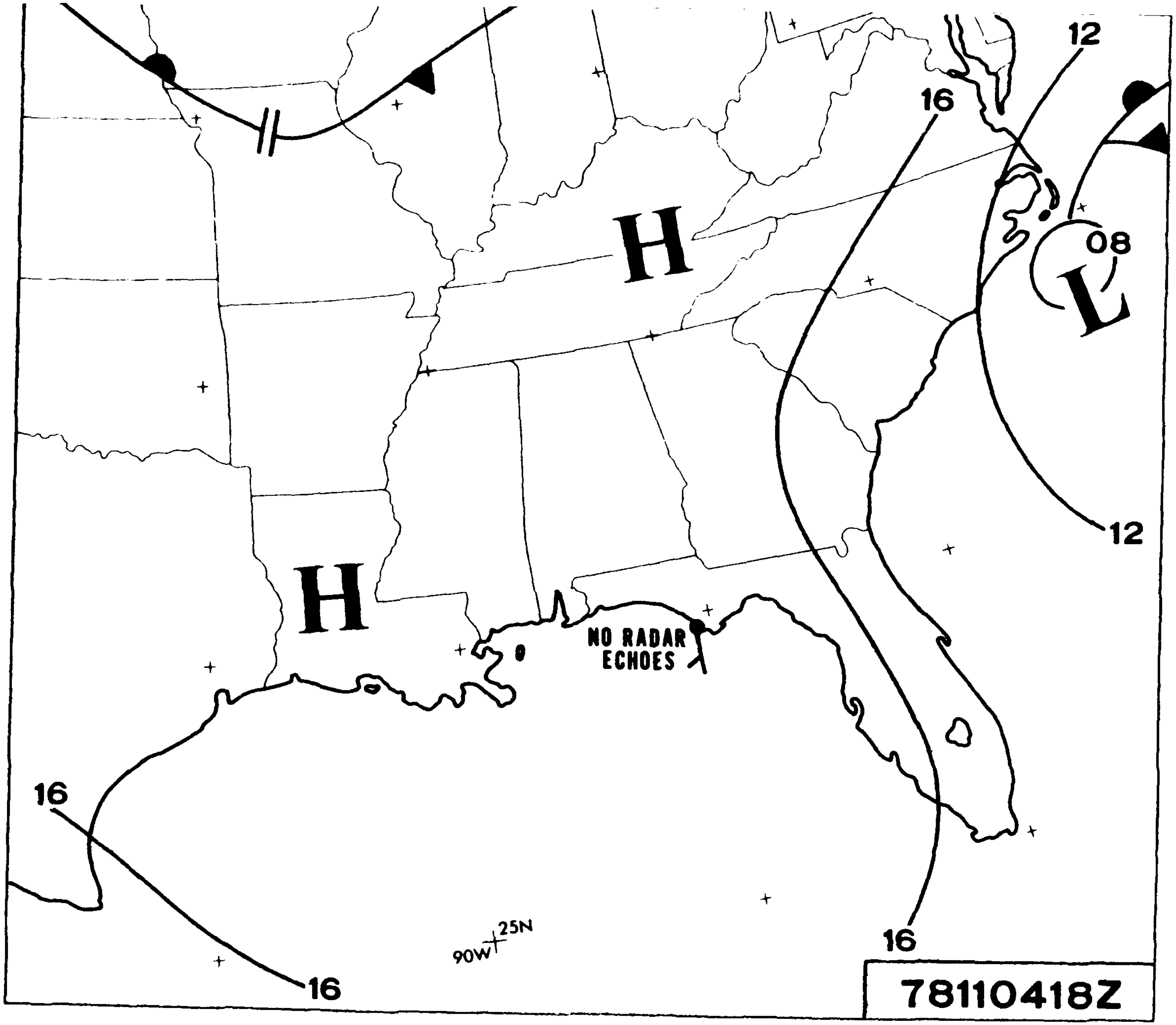


Figure 3-7 78110418Z Synoptic Chart

Table 3-1. Case 3, Apalachicola Surface Weather, 04 Nov 78, 0500Z - 04 Nov 78, 1700Z.

Date-Time (1978) (Z)	Temperature (^{o}C)	Dew-Point Depression (^{o}C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 04 03	15.6	1.7	340	4	CLR	7	None
06	12.8	1.1	40	5	CLR	4	H
09	10.0	1.1	--	--	CLR	5	--
12	10.0	3.3	60	3	CLR	5	H
15	18.9	15.0	60	6	CLR	7	None
18	23.3	15.5	190	4	CLR	7	None
21	22.8	13.4	200	5	CLR	7	None

Table 3-2. Case 3, Tyndall Surface Weather, 04 Nov 78, 0500Z - 04 Nov 78, 1700Z.

Date-Time (1978) (Z)	Temperature (^{o}C)	Dew-Point Depression (^{o}C)	Wind Depression (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 04 03	16.1	4.4	CALM	CALM	CLR	7	None
06	14.4	4.4	40	3	CLR	7	None
09	14.4	7.7	50	2	CLR	7	None
12	12.8	7.8	CALM	CALM	CLR	7	None
15	20.0	15.0	90	4	CLR	7	None
18	23.9	18.9	180	3	CLR	10	None
21	23.9	16.1	240	8	CLR	10	None

Table 3-3. Case 3, Eglin Surface Weather, 04 Nov 78, 0500Z - 04 Nov 78, 1700Z.

Date-Time (1978) (Z)	Temperature (^{o}C)	Dew-Point Depression (^{o}C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 04 03	18.3	12.2	300	1	CLR	10	None
06	16.1	10.0	310	2	CLR	10	None
09	12.2	5.5	CALM	CALM	CLR	10	None
12	11.7	5.0	CALM	CALM	CLR	5	F
15	20.6	12.8	CALM	CALM	CLR	7	None
18	23.9	13.3	180	9	CLR	7	None
21	23.3	10.0	190	8	CLR	7	None

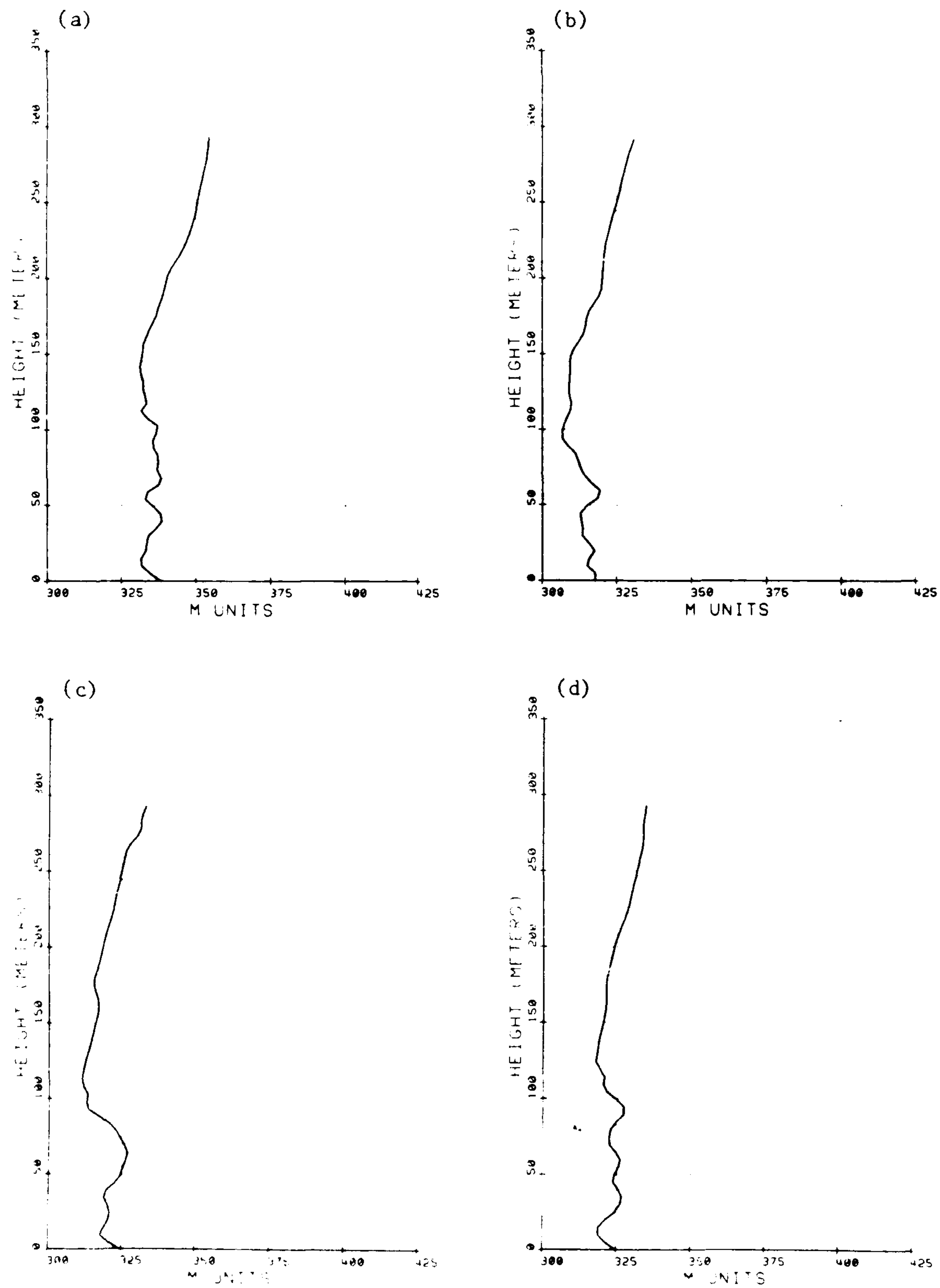


Figure 3-8 Case 3 M-Profiles: a. Cape San Blas, 4 Nov 78, 0800Z; b. Cape San Blas, 4 Nov 78, 1000Z; c. Cape San Blas, 4 Nov 78, 1200Z; d. Cape San Blas, 4 Nov 78, 1400Z.

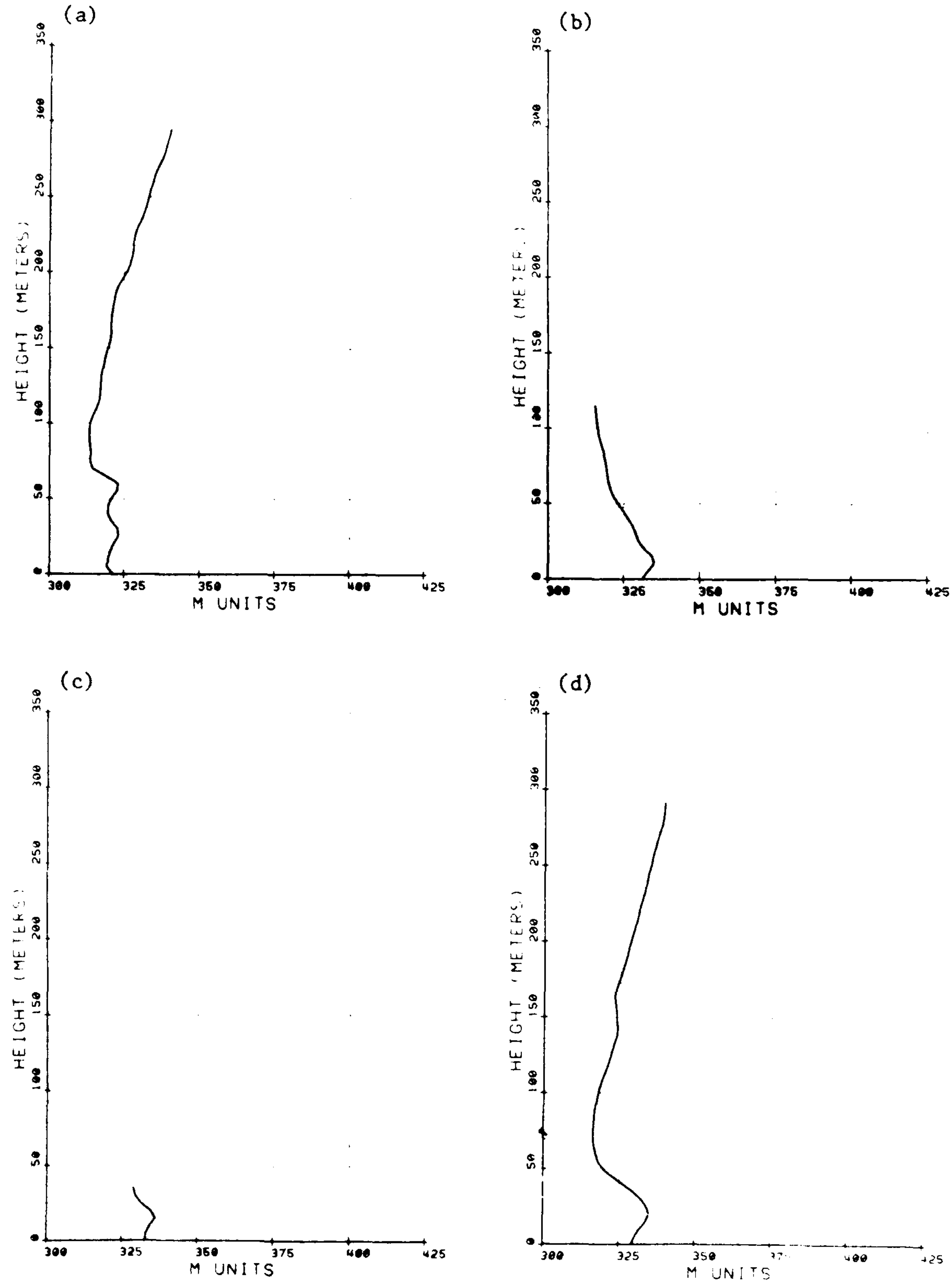


Figure 3-9 Case 3 M-Profiles: a. Cape San Blas, 4 Nov 78, 1600Z; b. White City, 4 Nov 78, 0800Z; c. White City, 4 Nov 78, 1000Z; d. White City, 4 Nov 78, 1700Z.

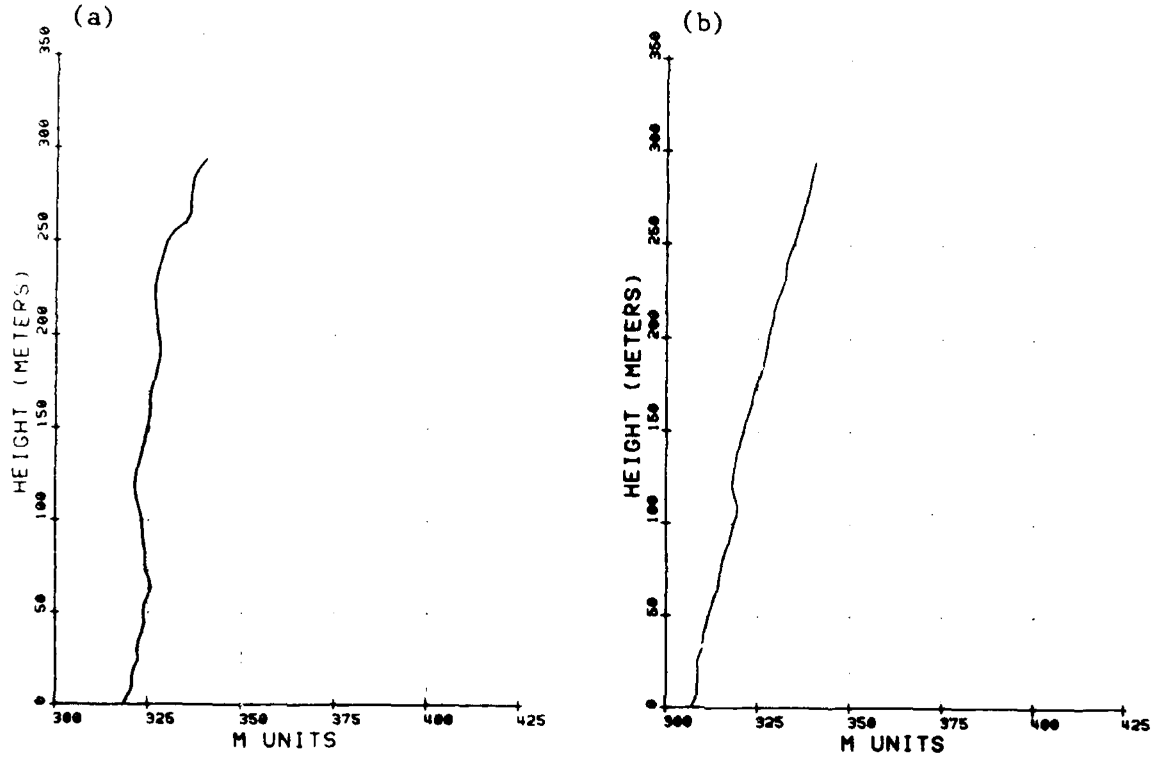


Figure 3-10 Case 3 M-Profiles: a. White City, 4 Nov 78, 1400Z; b. White City, 4 Nov 78, 1600Z.

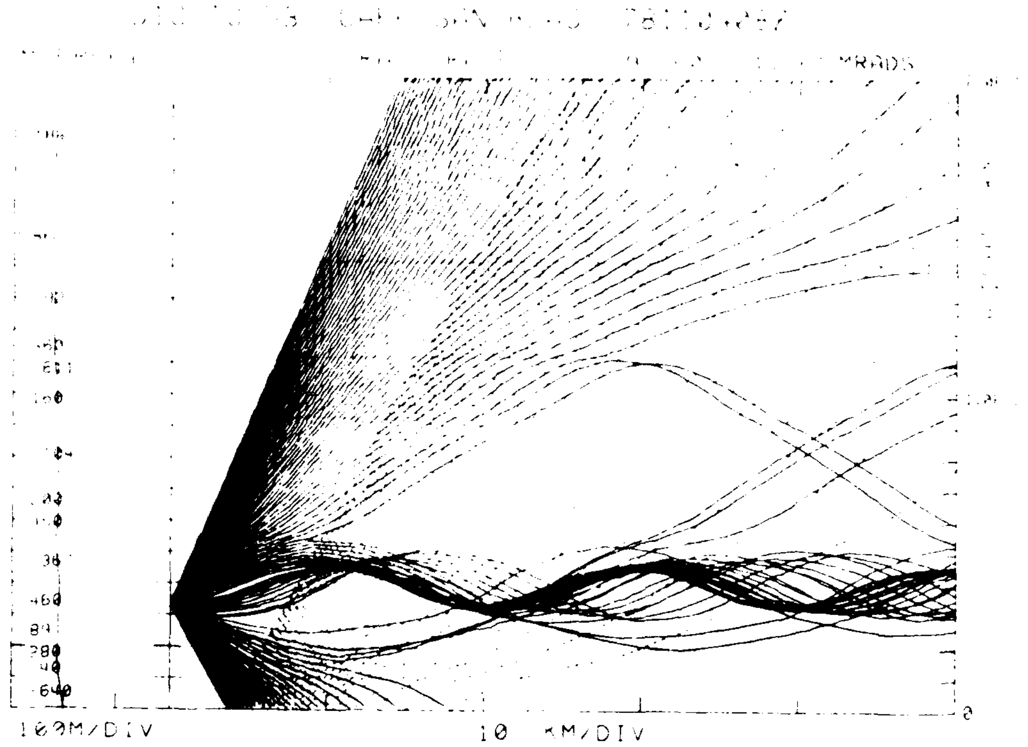


Figure 3-11. Case 3 Raytrace, D1C to D3, Cape San Blas, 4 Nov 78, 0800Z, Transmitter Height 33.5 m.

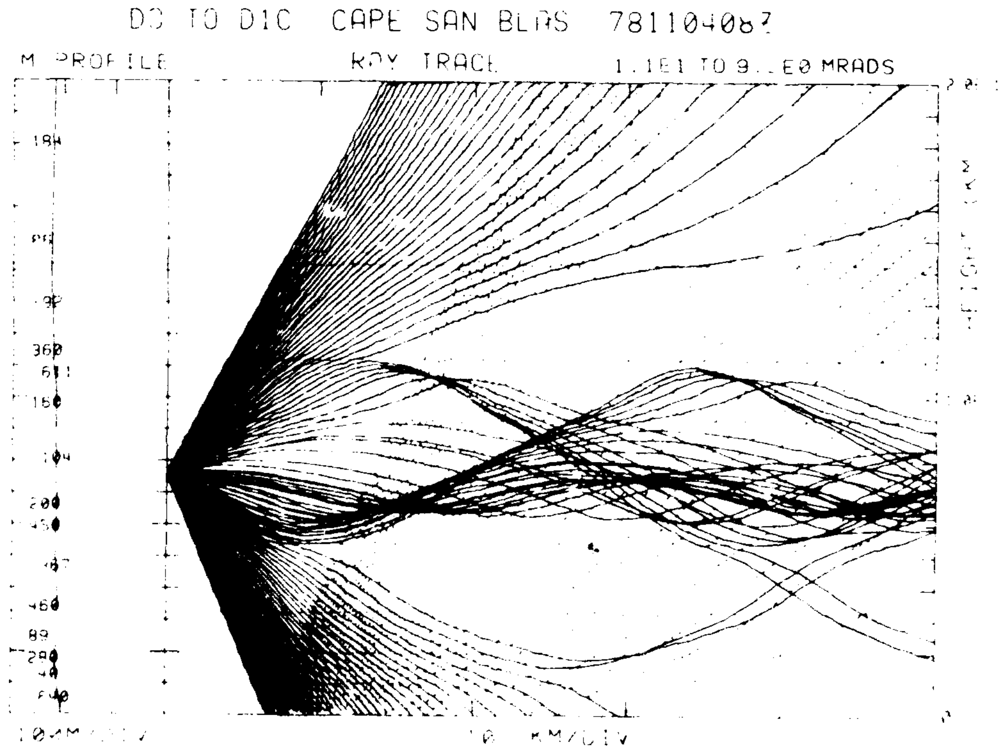


Figure 3-12. Case 3 Raytrace, D3 to D1C, Cape San Blas, 4 Nov 78, 0800Z, Transmitter Height 76.2 m.

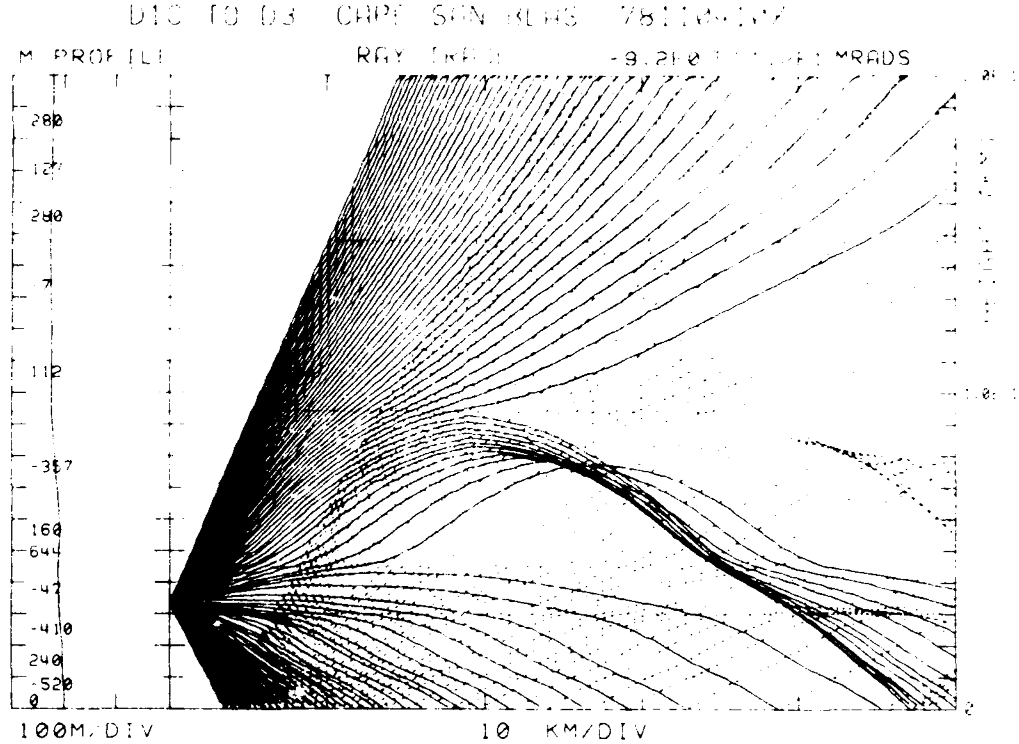


Figure 3-13. Case 3 Raytrace, D1C to D3, Cape San Blas, 4 Nov 78, 1000Z, Transmitter Height 33.5 m.

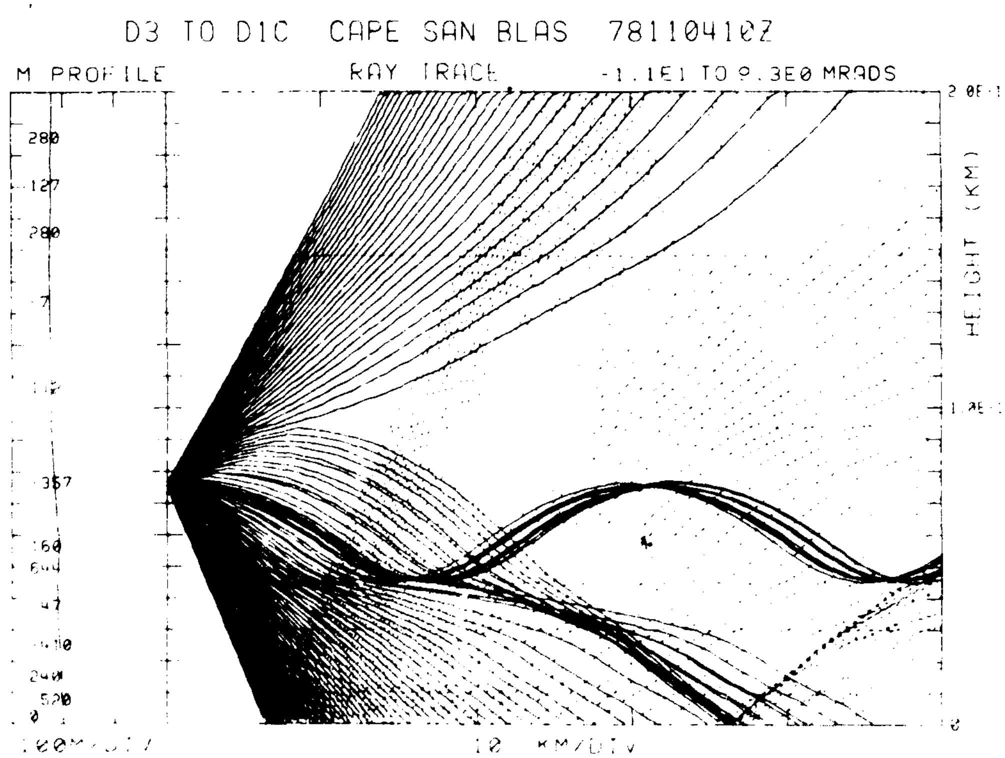


Figure 3-14. Case 3 Raytrace, D3 to D1C, Cape San Blas, 4 Nov 78, 1000Z, Transmitter Height 76.2 m.

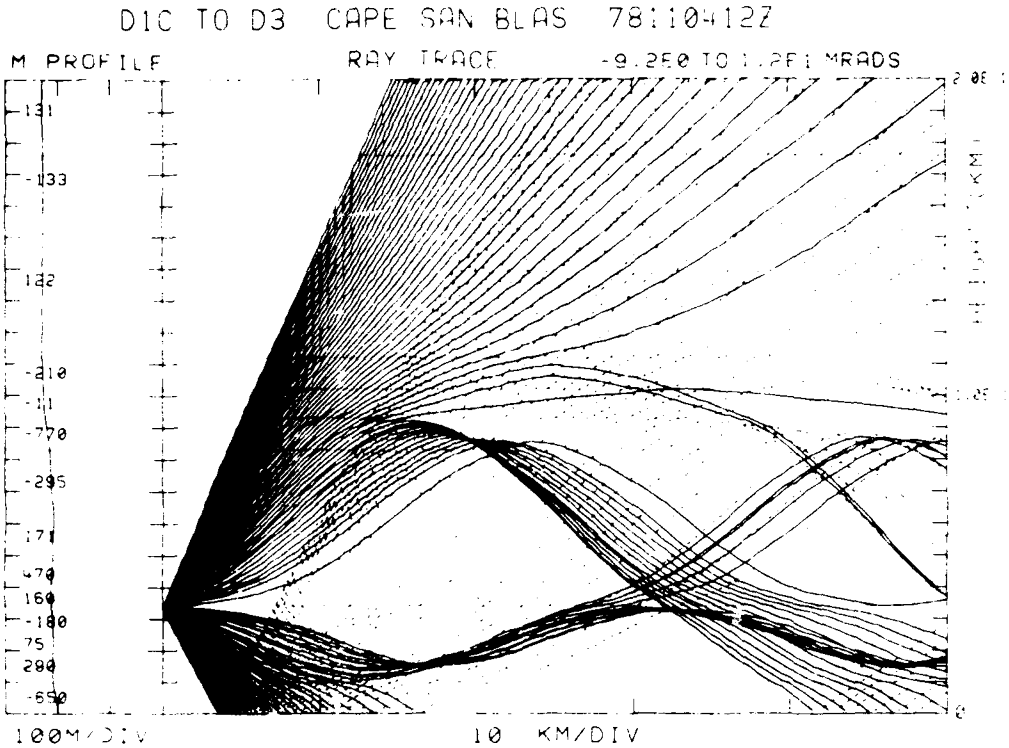


Figure 3-15. Case 3 Raytrace, D1C to D3, Cape San Blas, 4 Nov 78, 1200Z, Transmitter Height 33.5 m.

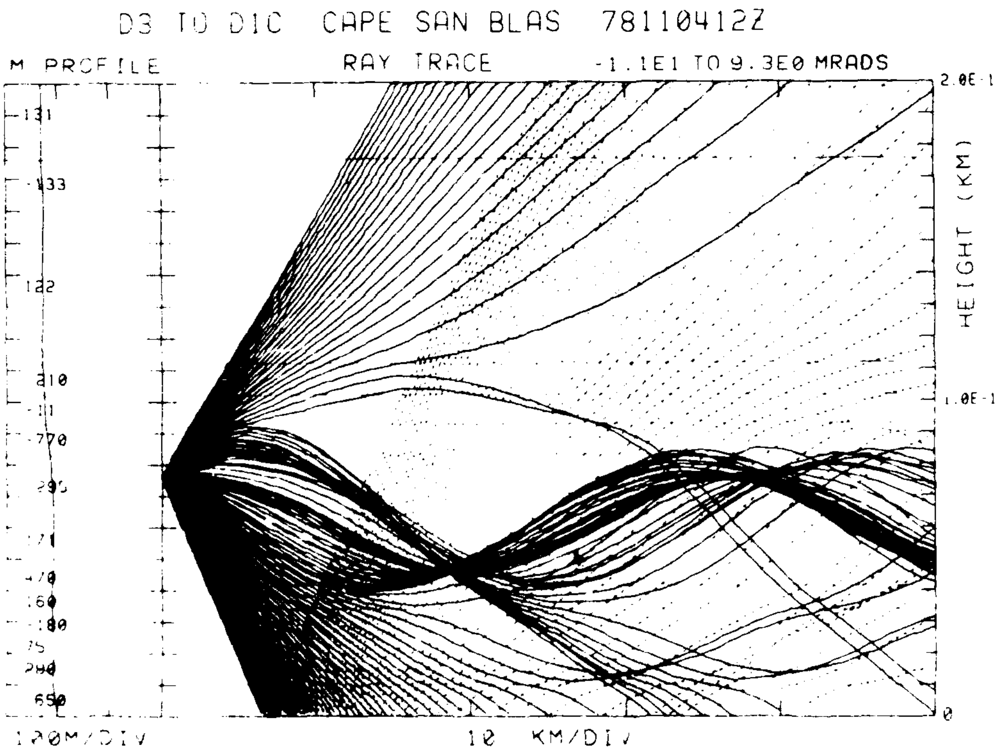


Figure 3-16. Case 3 Raytrace, D3 to D1C, Cape San Blas, 4 Nov 78, 1200Z, Transmitter Height 76.2 m.

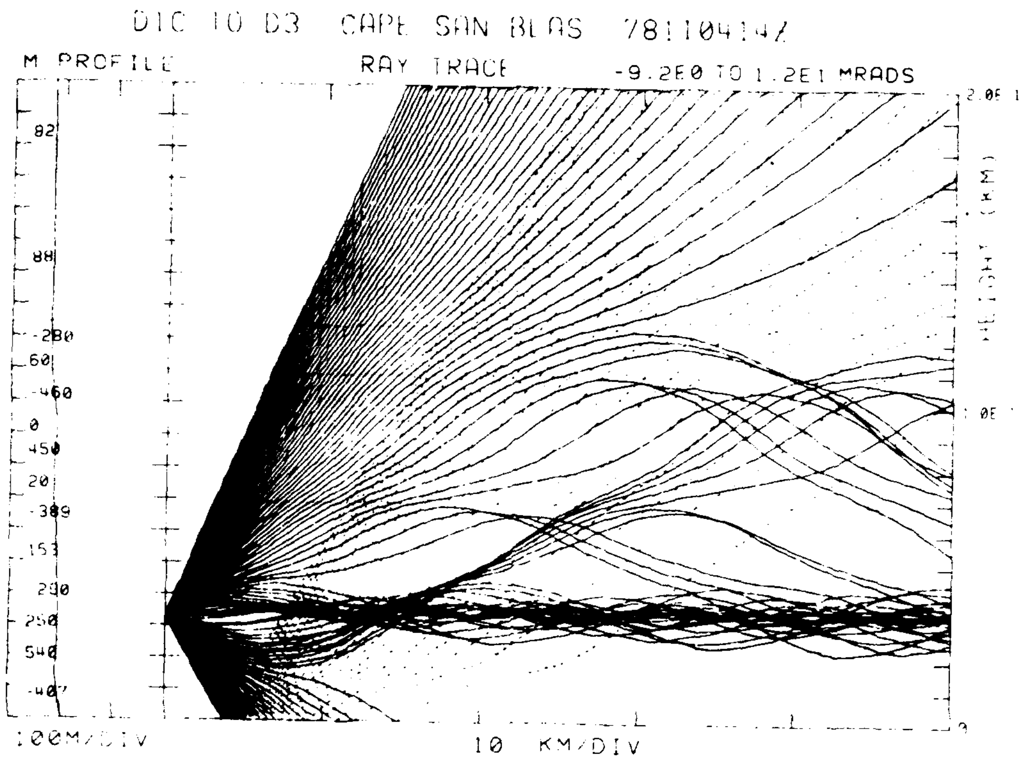


Figure 3-17. Case 3 Raytrace, D1C to D3, Cape San Blas, 4 Nov 78, 1400Z, Transmitter Height 33.5 m.

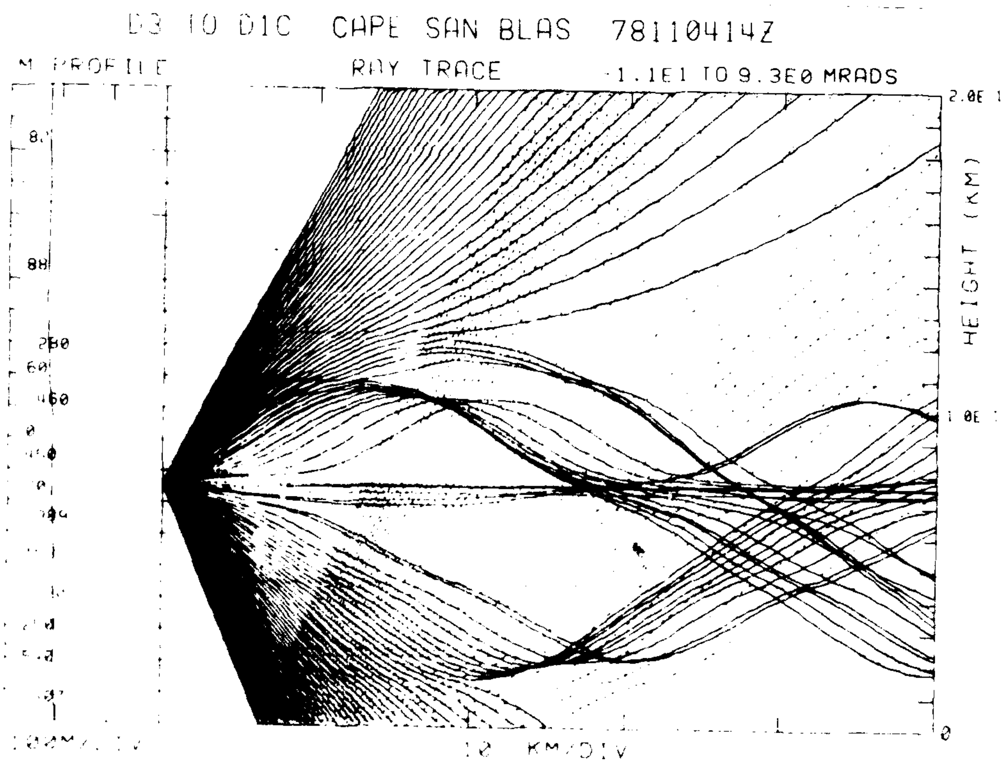


Figure 3-18. Case 3 Raytrace, D3 to D1C, Cape San Blas, 4 Nov 78, 1400Z, Transmitter Height 76.2 m.

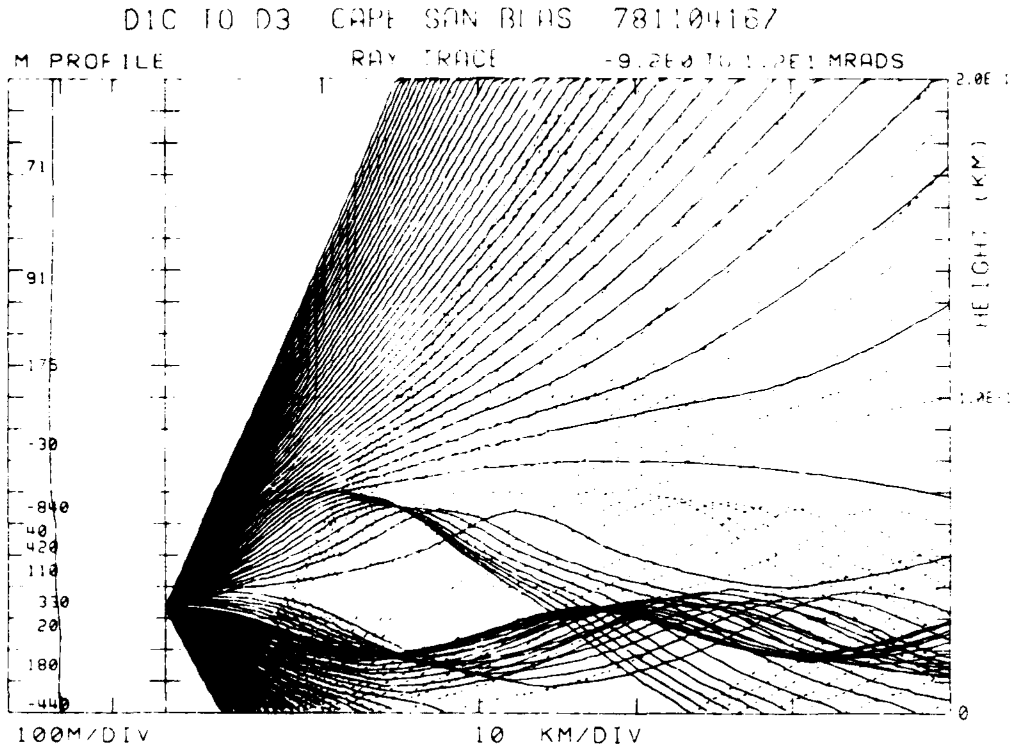


Figure 3-19. Case 3 Raytrace, D1C to D3, Cape San Blas, 4 Nov 78, 1600Z, Transmitter Height 33.5 m.

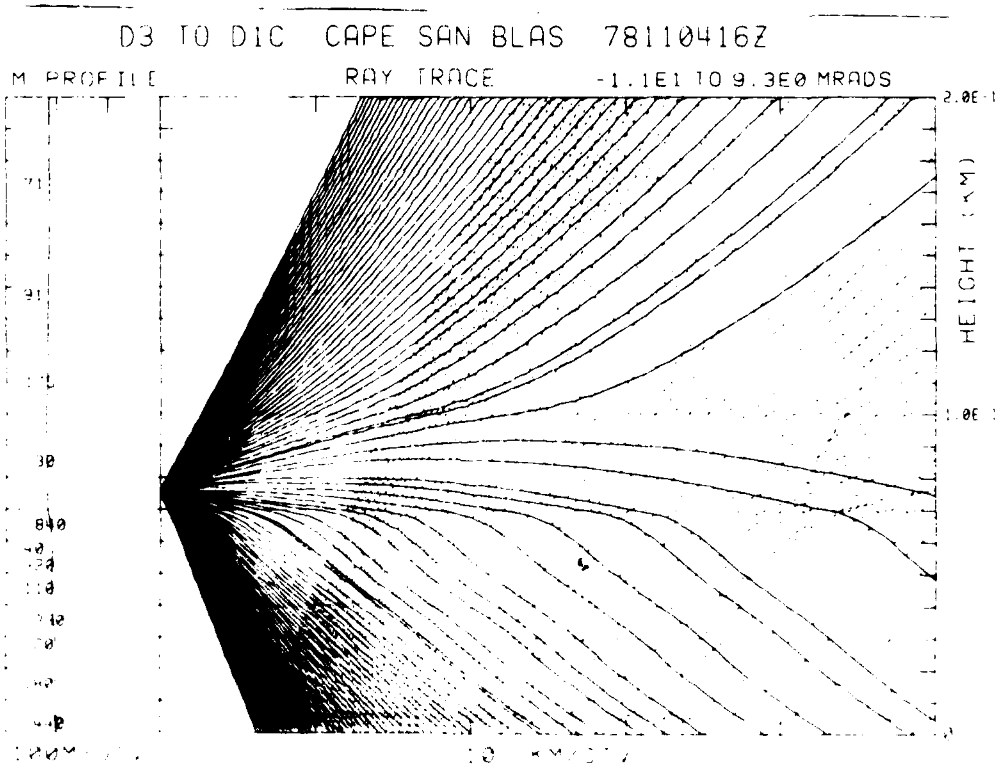


Figure 3-20. Case 3 Raytrace, D3 to D1C, Cape San Blas, 4 Nov 78, 1600Z, Transmitter Height 76.2 m.

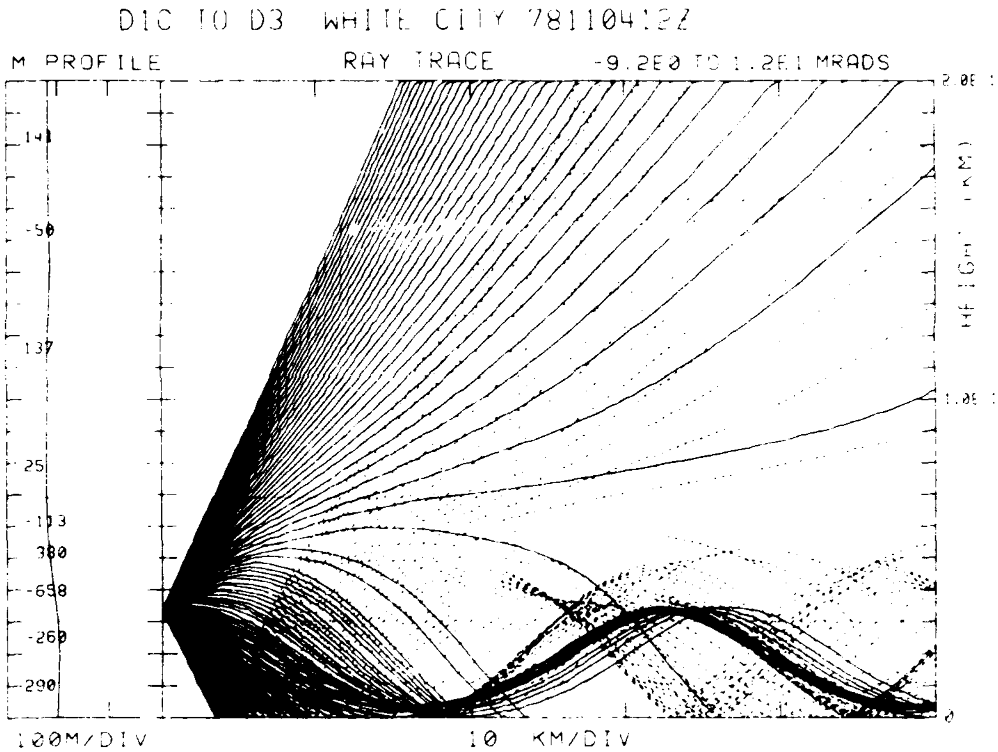


Figure 3-21. Case 3 Raytrace, D1C to D3, White City, 4 Nov 78, 1200Z, Transmitter Height 33.5 m.

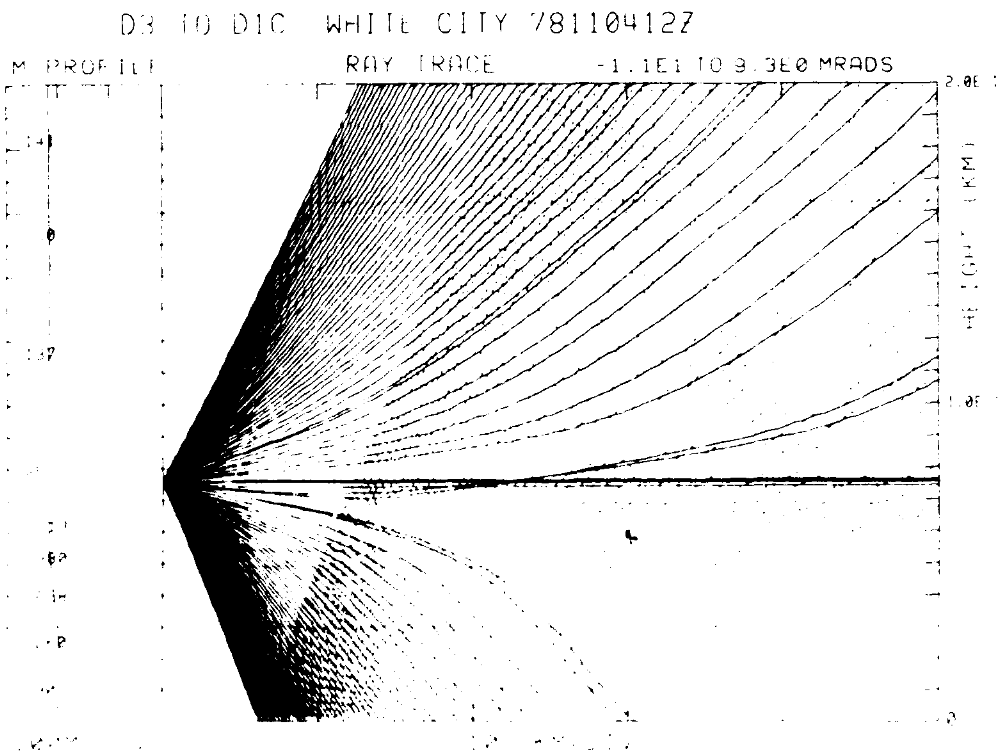


Figure 3-22. Case 3 Raytrace, D3 to D1C, White City, 4 Nov 78, 1200Z, Transmitter Height 76.2 m.

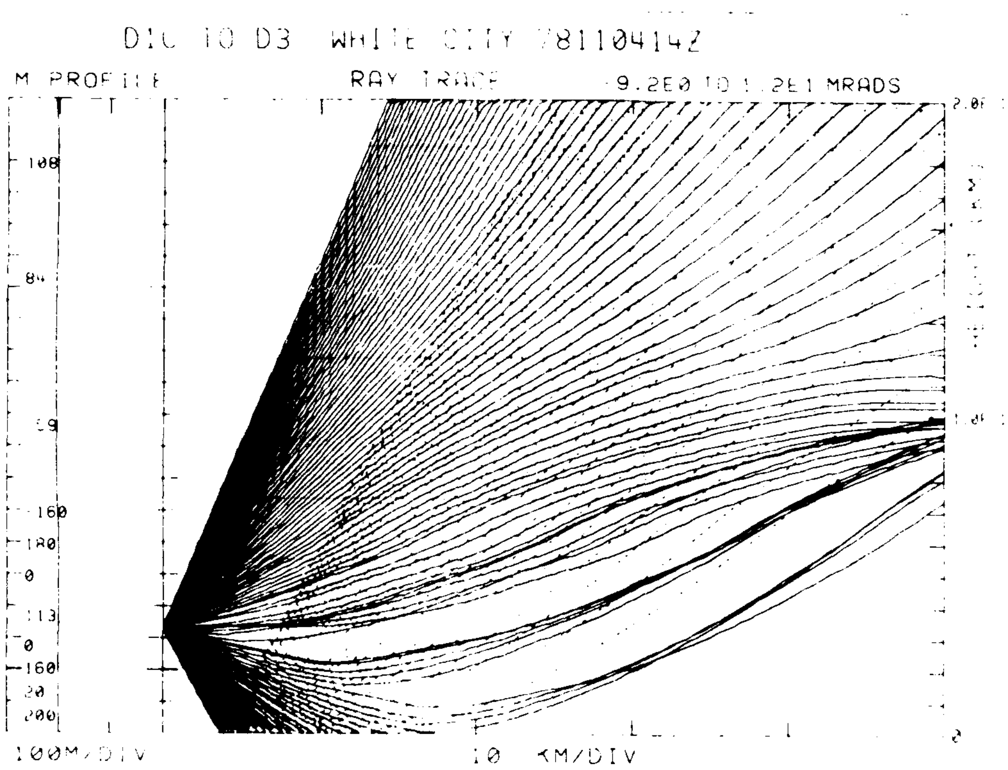


Figure 3-23. Case 3 Raytrace, D1C to D3, White City, 4 Nov 78, 1400Z, Transmitter Height 33.5 m.

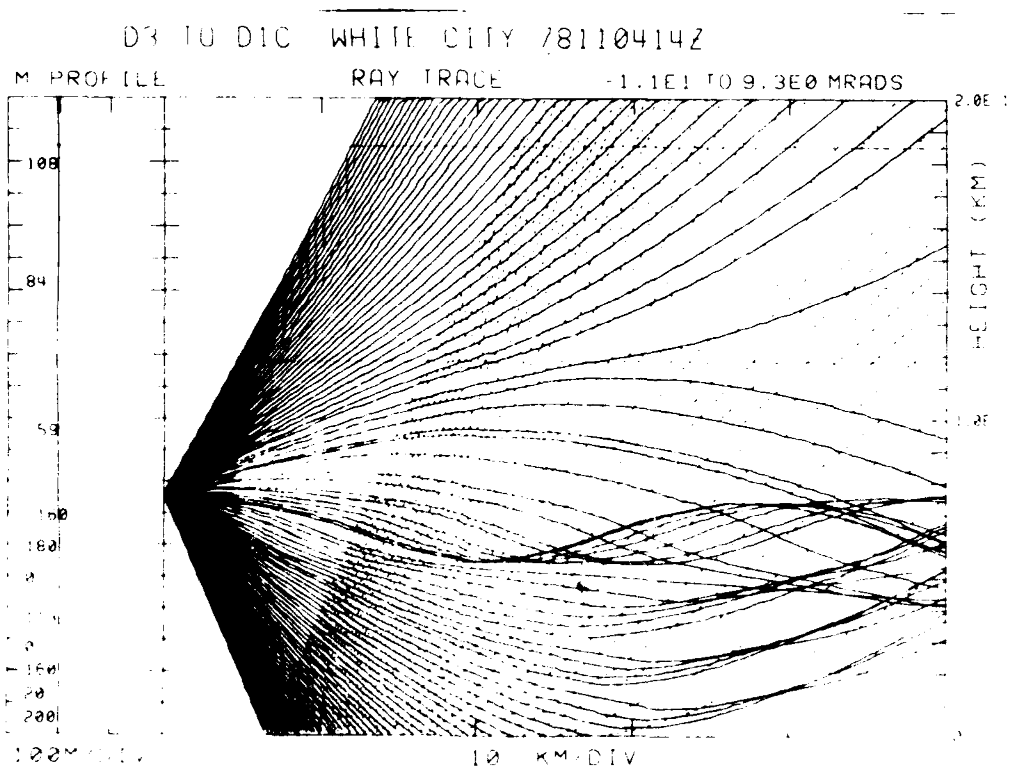


Figure 3-24. Case 3 Raytrace, D3 to D1C, White City, 4 Nov 78, 1400Z, Transmitter Height 76.2 m.

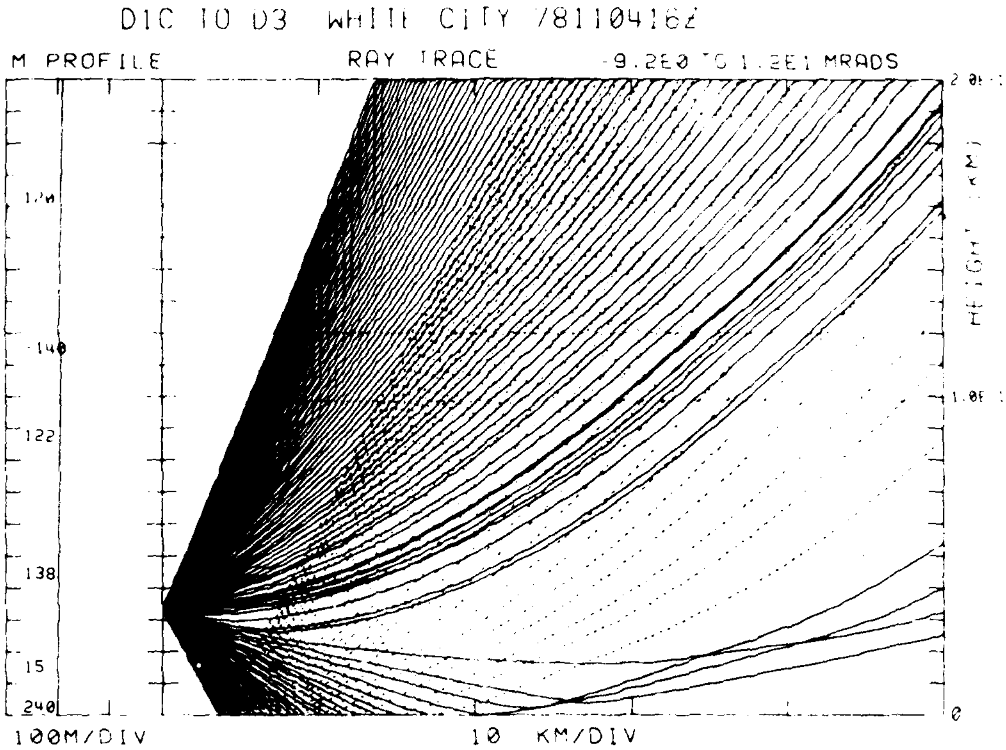


Figure 3-25. Case 3 Raytrace, D1C to D3, White City, 4 Nov 78, 1600Z, Transmitter Height 33.5 m.

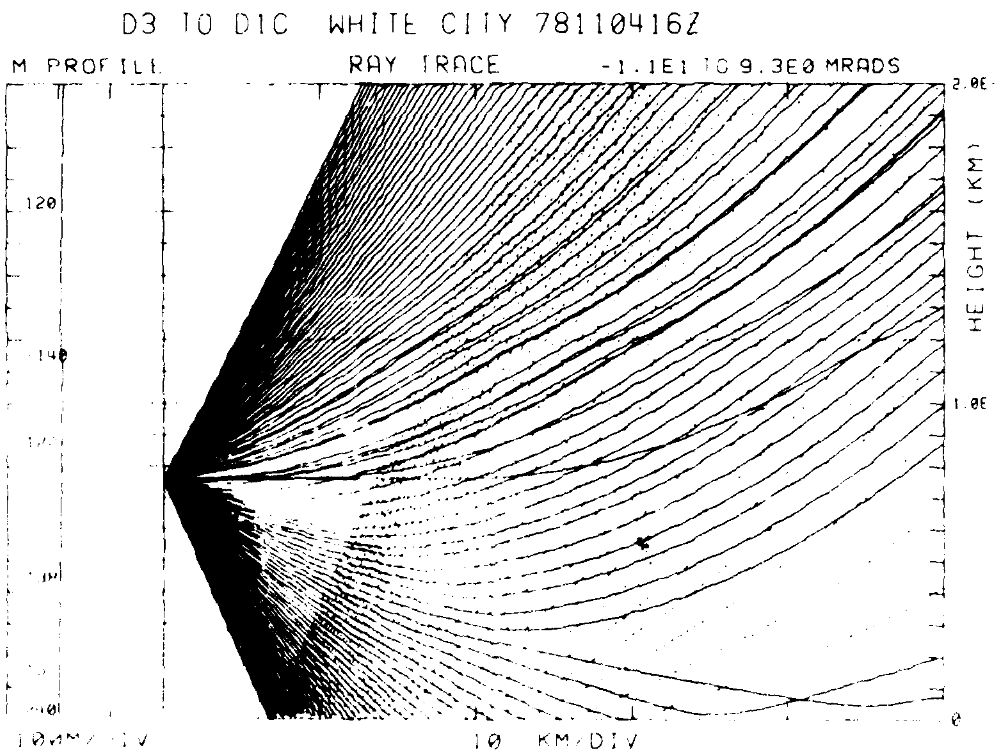


Figure 3-26. Case 3 Raytrace, D3 to D1C, White City, 4 Nov 78, 1600Z, Transmitter Height 76.2 m.

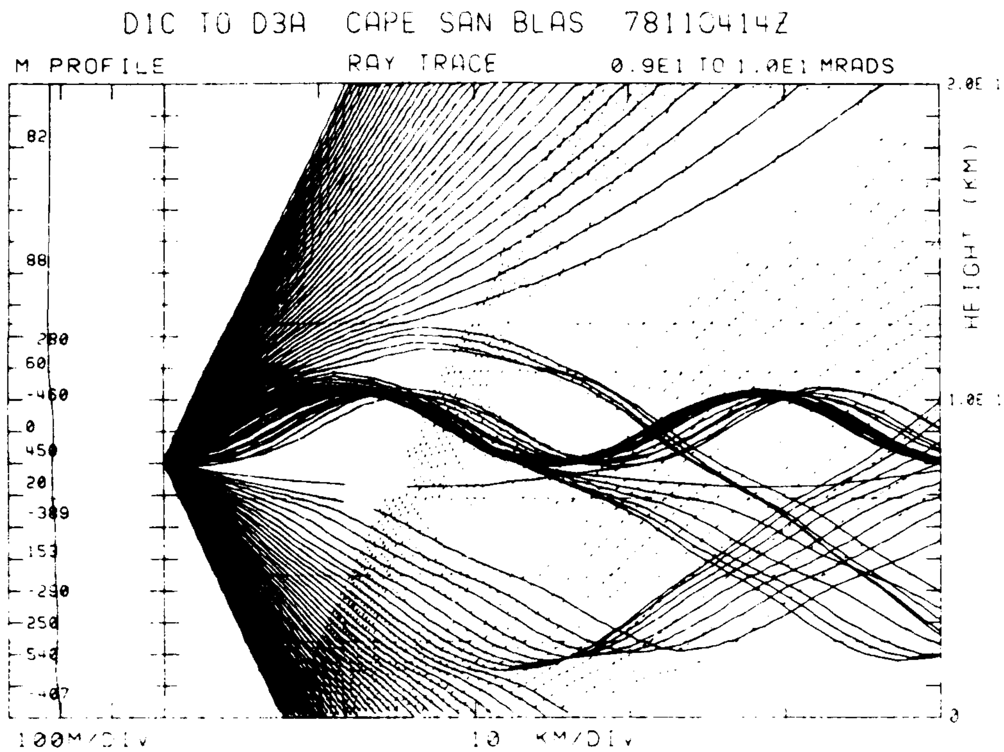


Figure 3-27. Case 3 Raytrace, DlC to D3A, Cape San Blas 4 Nov 78, 1400Z, Transmitter Height 80.8 m.

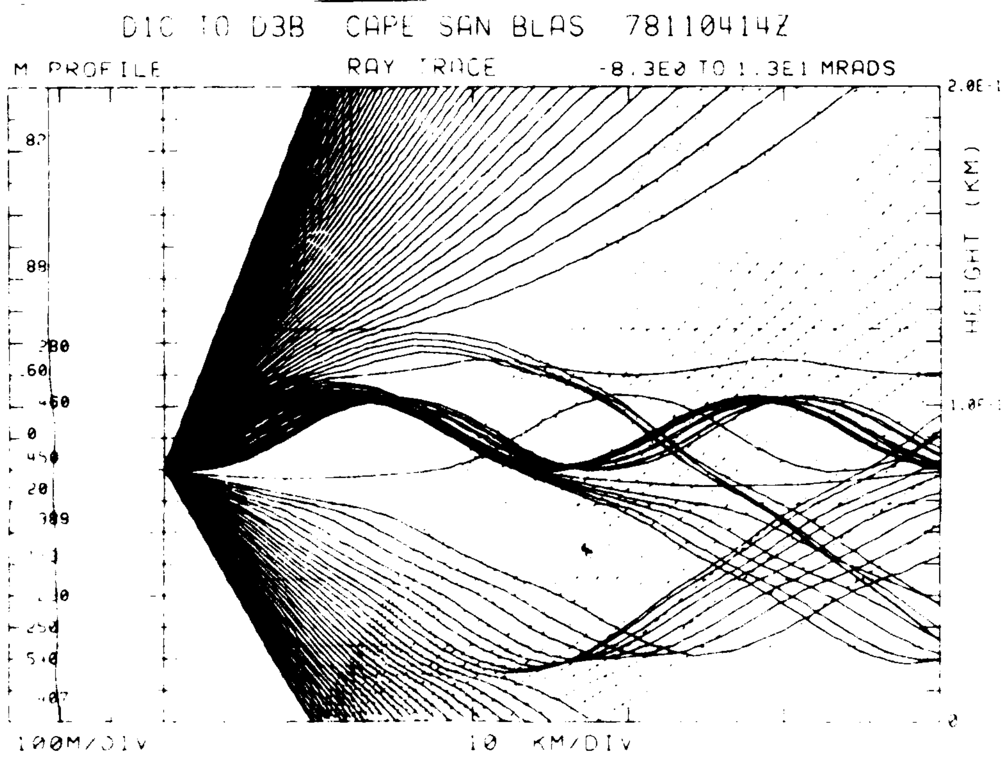


Figure 3-28. Case 3 Raytrace, DlC to D3B, Cape San Blas 4 Nov 78, 1400Z, Transmitter Height 80.8 m.

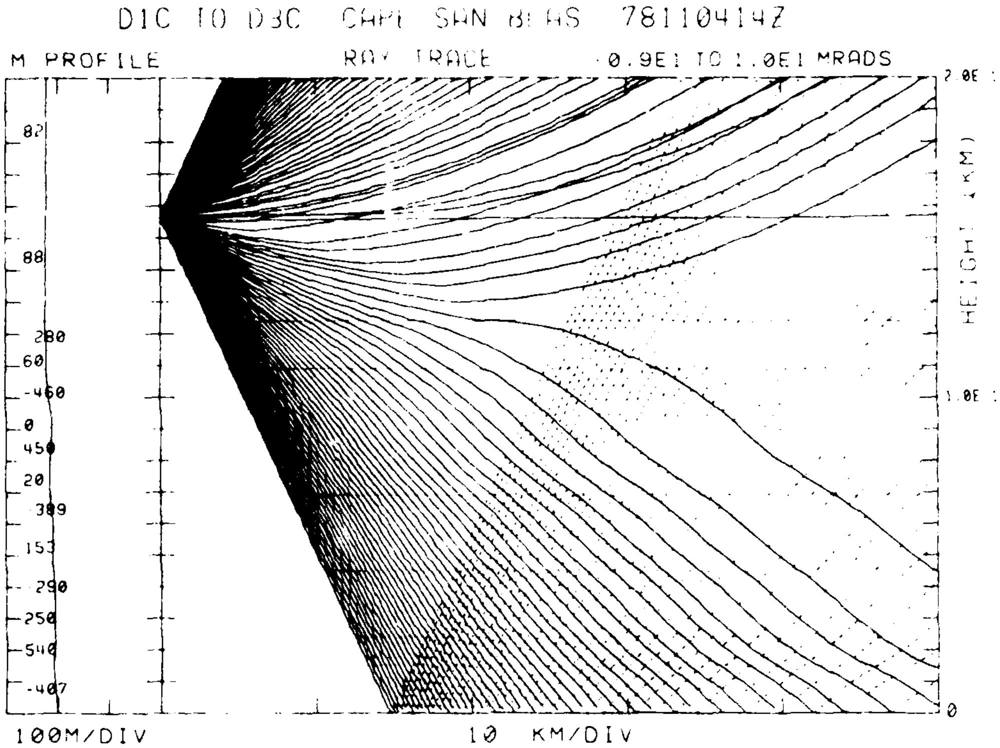


Figure 3-29. Case 3 Raytrace, D1C to D3C, Cape San Blas 4 Nov 78, 1400Z, Transmitter Height 157.0 m.

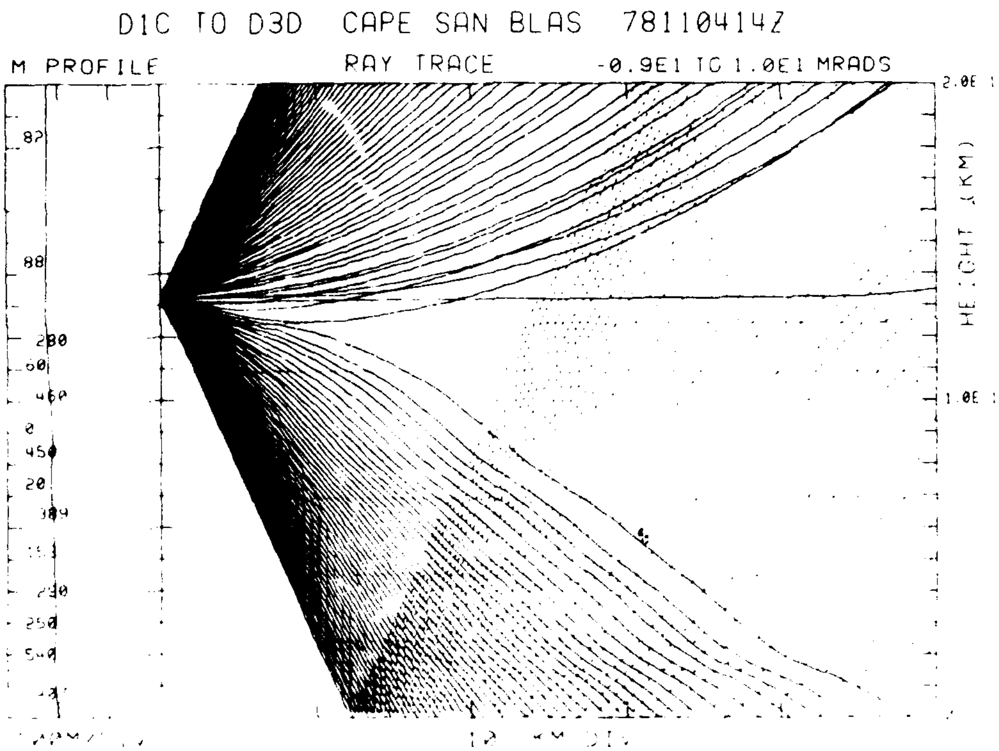


Figure 3-30. Case 3 Raytrace, D1C to D3D, Cape San Blas 4 Nov 78, 1400Z, Transmitter Height 132.7 m.

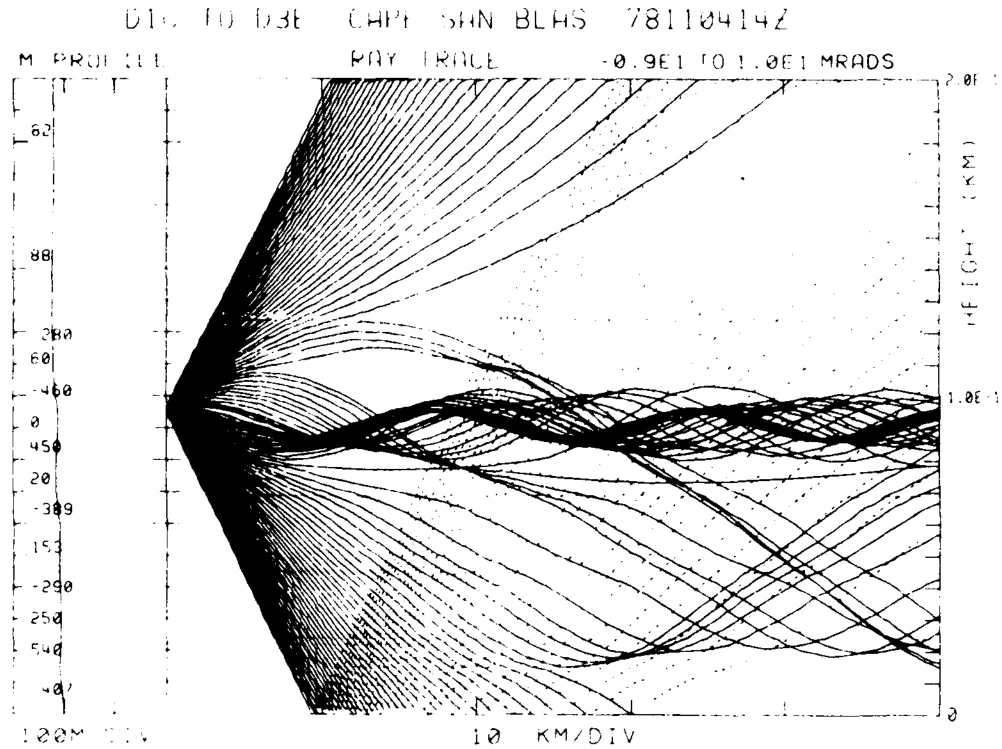


Figure 3-31. Case 3 Raytrace, D1C to D3E, Cape San Blas
4 Nov 78, 1400Z, Transmitter Height 96.0 m.

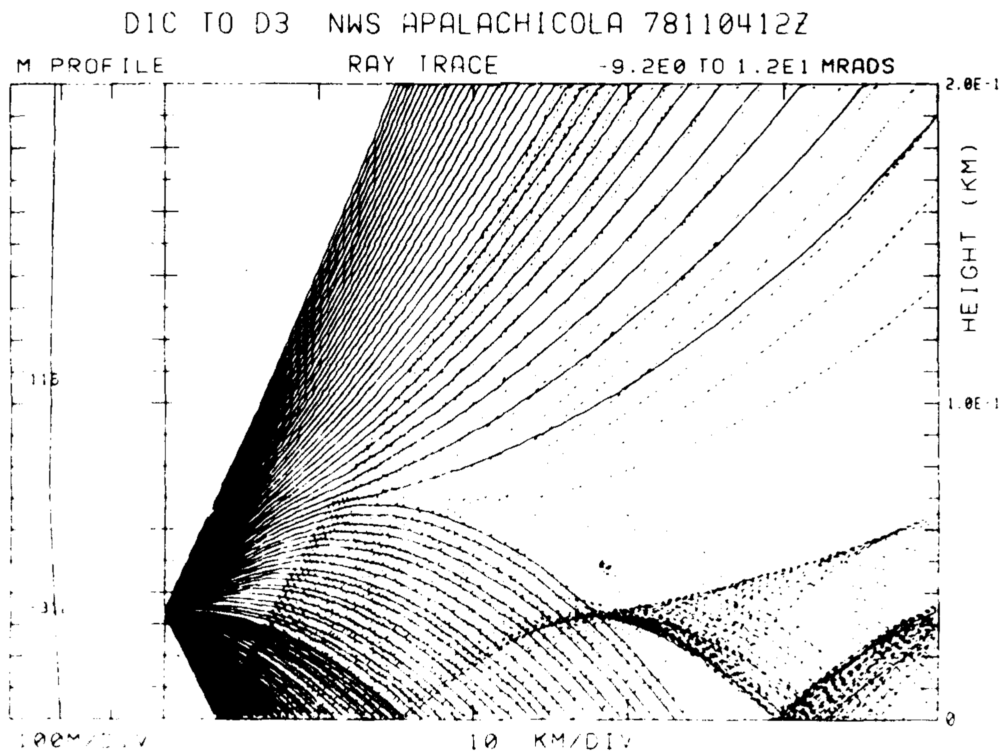


Figure 3-32. Case 3 Raytrace, D1C to D3, NWS Apalachicola
4 Nov 78, 1200Z, Transmitter Height 33.5 m.

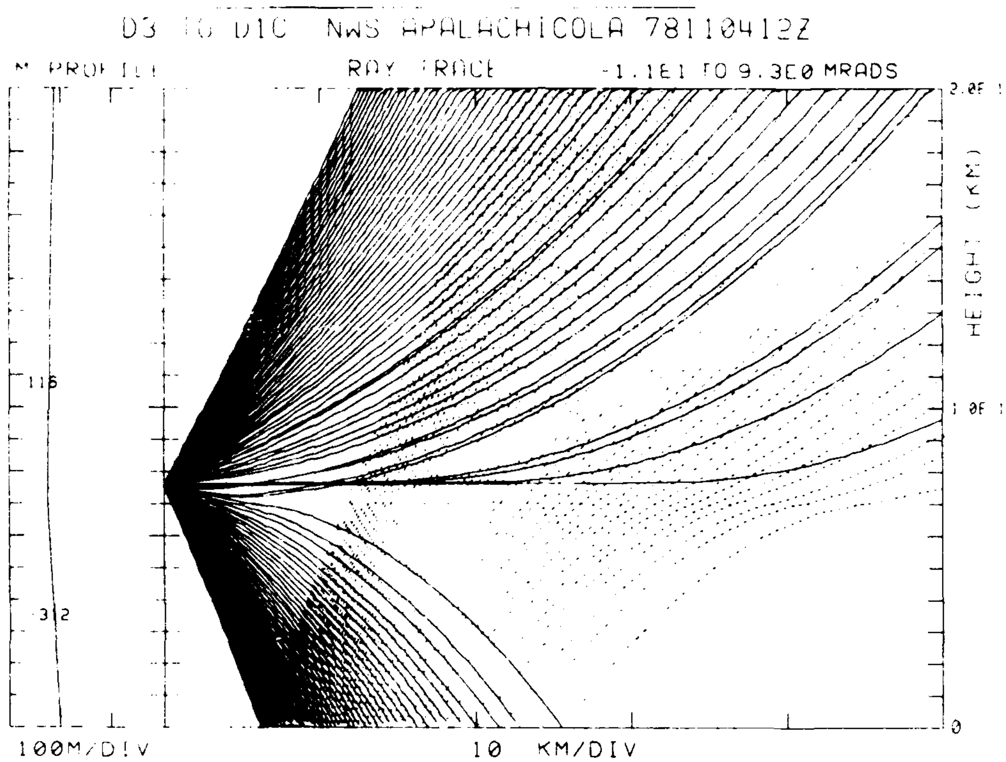


Figure 3-33. Case 3 Raytrace, D3 to D1C, NWS Apalachicola 4 Nov 78, 1200Z, Transmitter Height 76.2 m.

CASE 4

1. Case 4 (5 Nov/05-18Z) involved the RSL recorded at D3 from D1C. Figures 4-1 and 4-2 are typical RSL recordings from the period.

2. Figures 4-3 through 4-5 depict the synoptic weather pattern, which is indicative of a weak pressure gradient, light-to-calm winds, no precipitation, and early-morning fog or haze.

3. Surface observations for the three stations (Tables 4-1 through 4-3) clearly reflect the synoptic pattern. Also, a weak sea breeze occurred in the afternoon.

4. M-profiles for all three tethered balloon sites were available for this case (Figures 4-6 through 4-9). A low-level duct was evident at both Apalachicola and White City, but not at Cape San Blas. Although there were weak fluctuations in M in many of the profiles, the level at which the profiles all become normal to near-normal was again at about 100 meters (except for very minor fluctuations in M).

5. Figures 4-10 through 4-42 depict the usual raytraces (existing antenna heights and the 158.4 meter antenna height at D3) for all M-profiles. An improved direct ray pattern is once again consistently evident when the 158.4 meter antenna height is used. Further improvement appears if the range between antennas decreases while keeping the high (158.4 meter) antenna configuration.

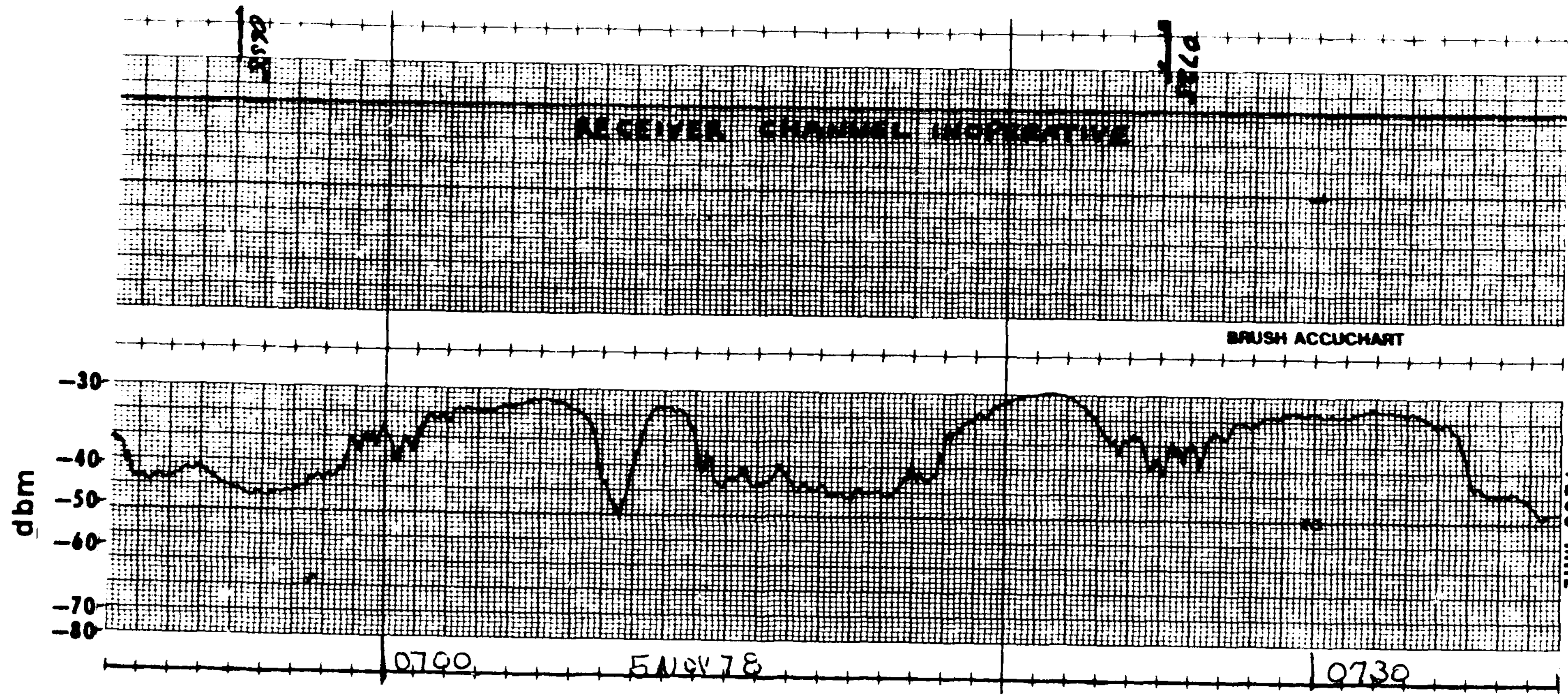


Figure 4-1 Case 4 RSL Strip Chart showing typical fade pattern on single channel (lower graph) of D3 received from D1C (channel on upper graph was inoperative). Times are from 0651 EST to 0738 EST, 5 Nov 78. The dbm calibration level is listed on the left, and channel frequency in MHz is listed on the right.

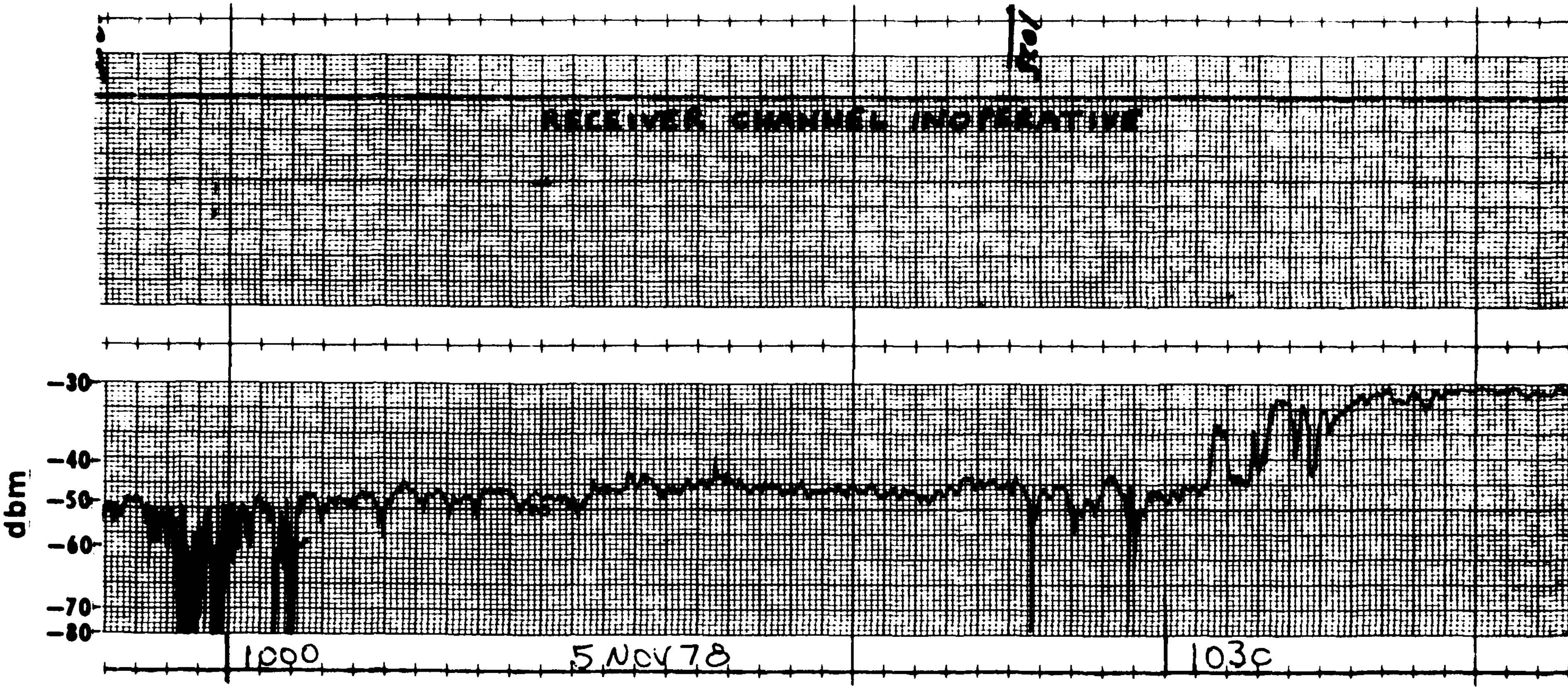


Figure 4-2 Case 4 RSL strip Chart showing typical fade pattern on single channel (lower graph) of D3 received from D1C (channel on upper graph was inoperative). Times are from 0956 EST to 1043 EST, 5 Nov 78. The dbm calibration levels are listed on the left, and channel frequency in MHz is listed on the right.

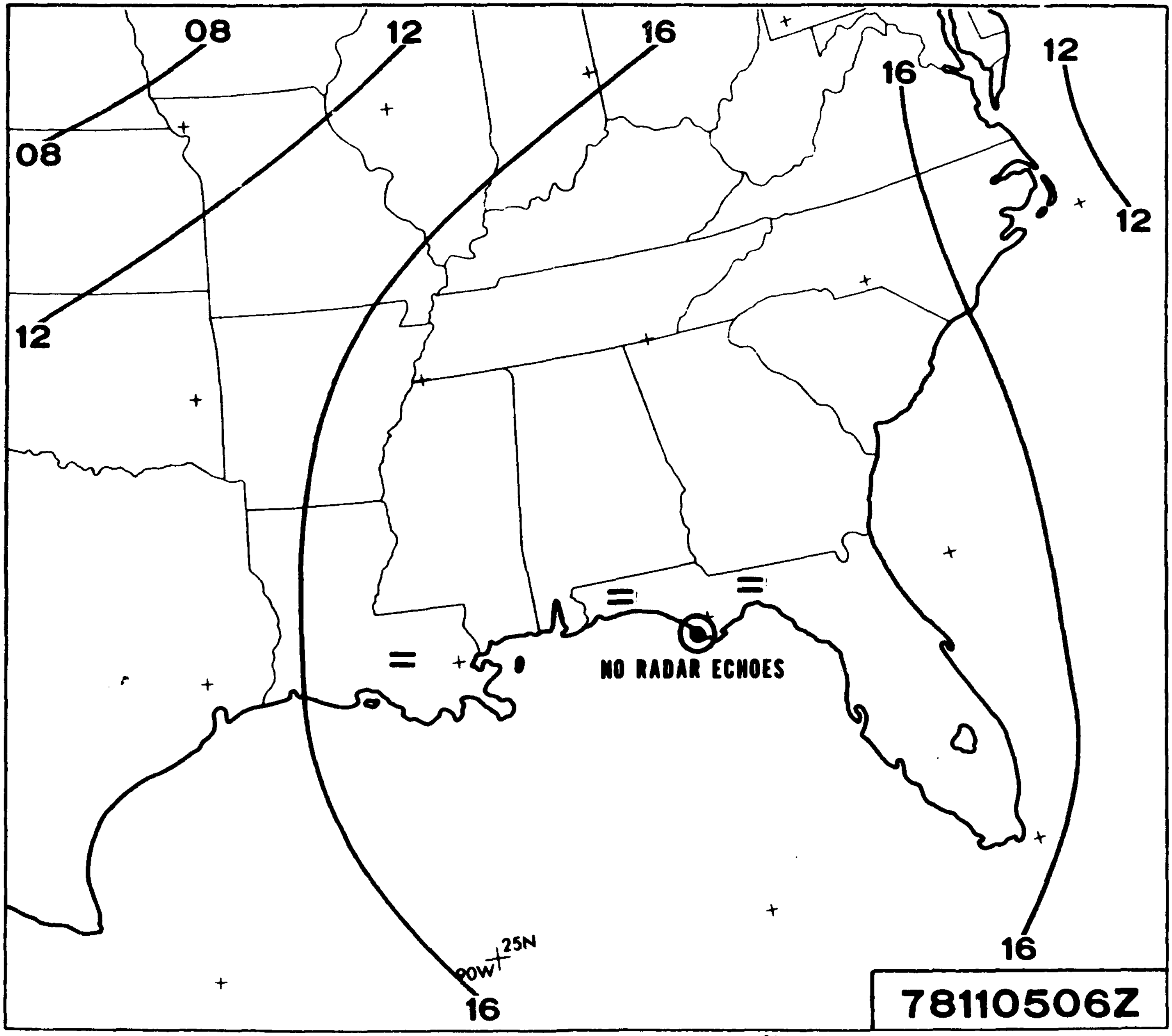


Figure 4-3 78110506Z Synoptic Chart

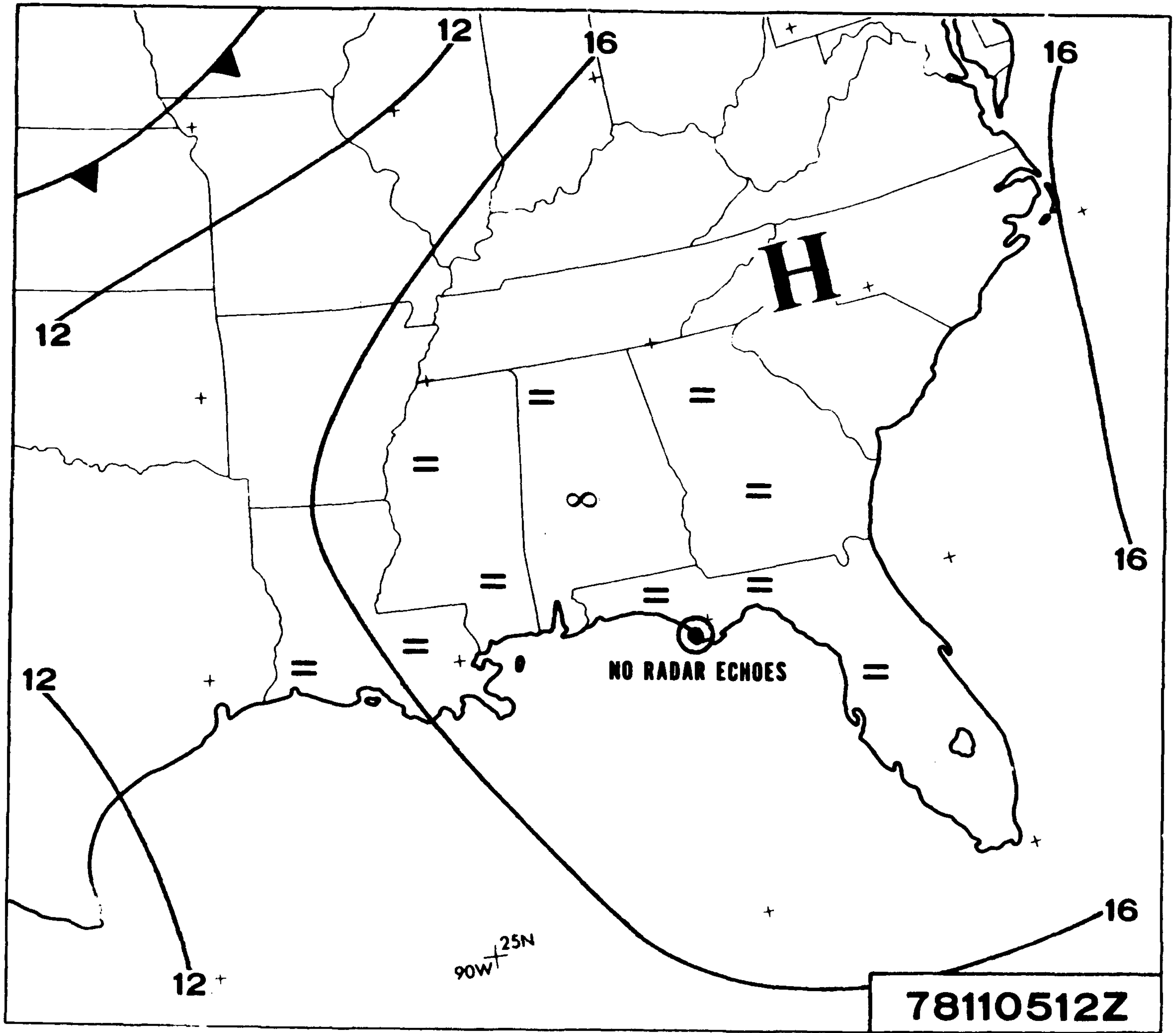


Figure 4-4 78110512Z Synoptic Chart

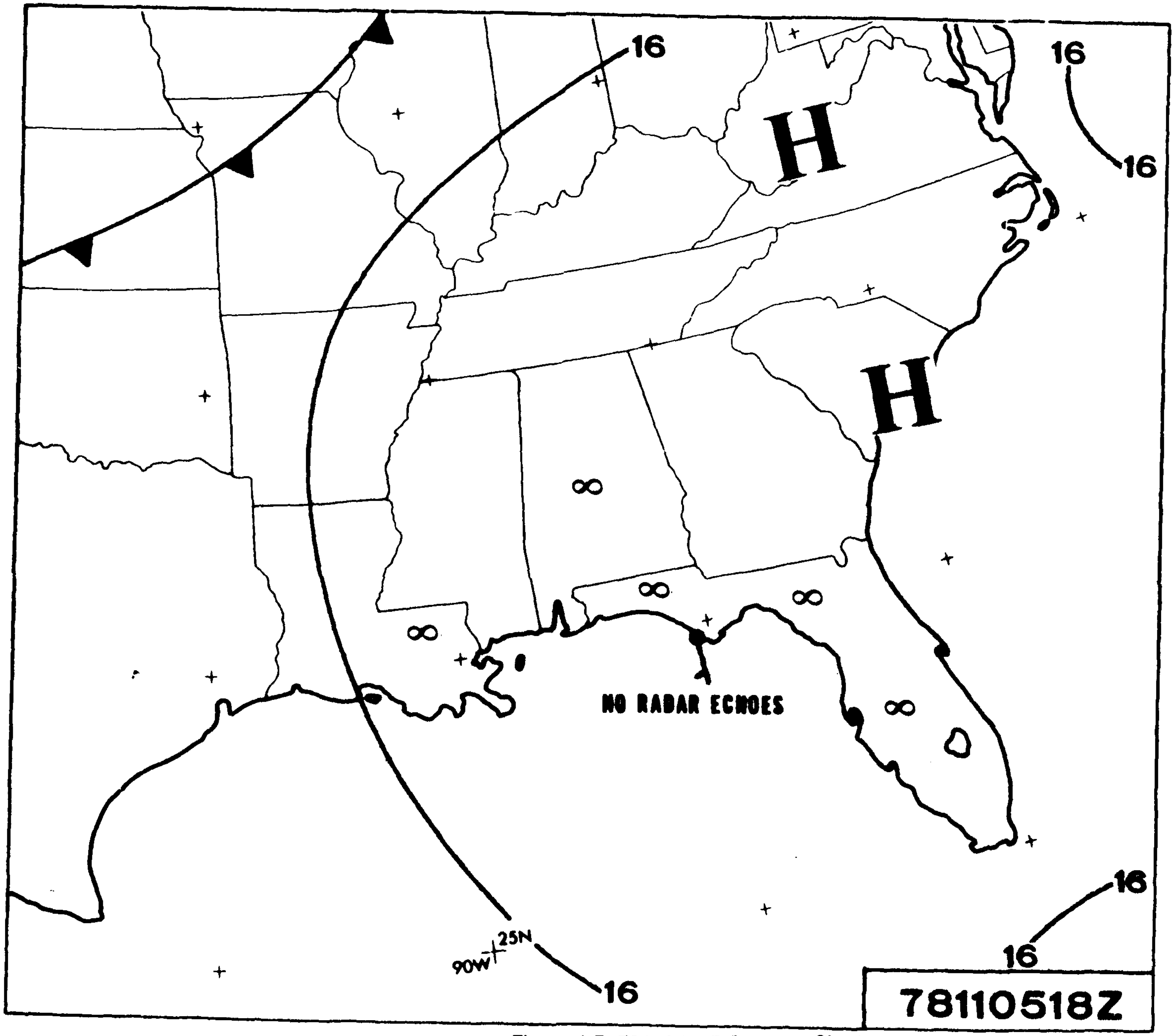


Figure 4-5 78110518Z Synoptic Chart

Table 4-1. Case 4, Apalachicola Surface Weather, 05 Nov 78, 0500Z - 05 Nov 78, 1800Z.

Date-Time (1978) (Z)	Temperature (^{o}C)	Dew-Point Depression (^{o}C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 05 03	10.6	1.2	CALM	CALM	CLR	7	None
06	10.0	1.1	CALM	CALM	CLR	5	H
09	9.4	0.5	CALM	CALM	CLR	5	H GF
12	8.9	1.1	CALM	CALM	CLR	4	GF H
15	22.2	10.0	220	4	CLR	7	None
18	--	--	--	--	--	--	--
21	23.3	12.7	170	7	CLR	7	None

Table 4-2. Case 4, Tyndall Surface Weather, 05 Nov 78, 0500Z - 05 Nov 78, 1800Z.

Date-Time (1978) (Z)	Temperature (^{o}C)	Dew-Point Depression (^{o}C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 05 03	14.4	5.5	CALM	CALM	CLR	10	None
06	12.8	3.9	CALM	CALM	CLR	10	None
09	13.3	3.3	CALM	CALM	CLR	5	F
12	12.8	3.9	CALM	CALM	CLR	4	F
15	21.7	7.8	80	4	CLR	7	None
18	25.0	15.6	210	5	CLR	7	None
21	24.4	15.5	220	4	CLR	7	None

Table 4-3. Case 4, Eglin Surface Weather, 05 Nov 78, 0500Z - 05 Nov 78, 1800Z.

Date-Time (1978) (Z)	Temperature (^{o}C)	Dew-Point Depression (^{o}C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 05 03	15.6	3.9	CALM	CALM	CLR	7	None
06	11.7	1.1	CALM	CALM	CLR	6	F
09	11.1	1.7	CALM	CALM	CLR	6	F
12	10.0	0.6	10	2	CLR	3	F
15	20.6	6.2	CALM	CALM	CLR	4	H
18	25.0	10.6	160	8	SCT	6	H
21	25.0	13.9	160	9	SCT	7	None

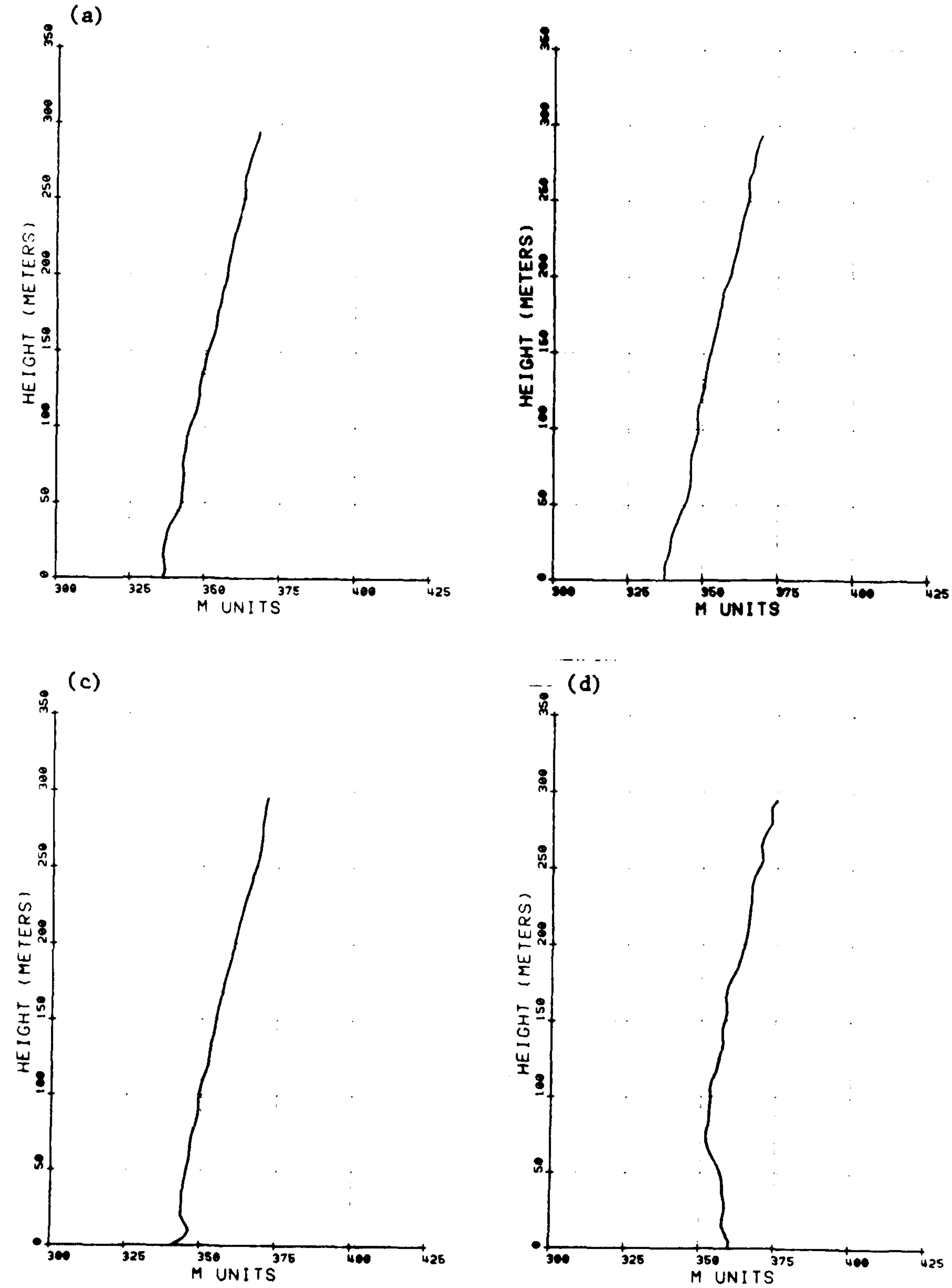


Figure 4-6 Case 4 M-Profiles: a. Cape San Blas, 5 Nov 78, 0800Z; b. Cape San Blas, 5 Nov 78, 1000Z; c. Cape San Blas, 5 Nov 78, 1200Z; d. Cape San Blas, 5 Nov 78, 1400Z.

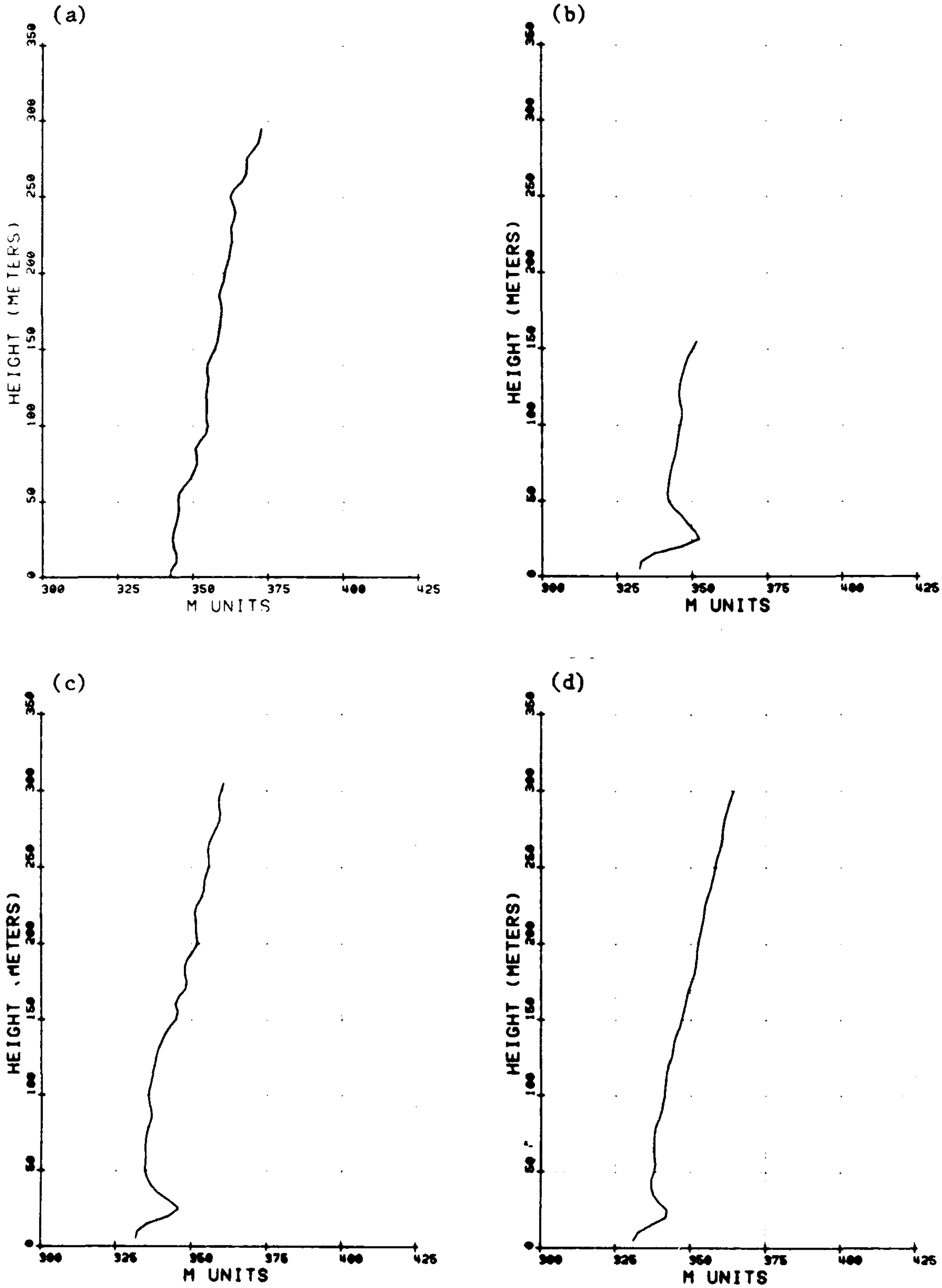


Figure 4-7 Case 4 M-Profiles: a. Cape San Blas, 5 Nov 78, 1600Z; b. Apalachicola, 5 Nov 78, 0800Z; c. Apalachicola, 5 Nov 78, 1000Z; d. Apalachicola, 5 Nov 78, 1200Z.

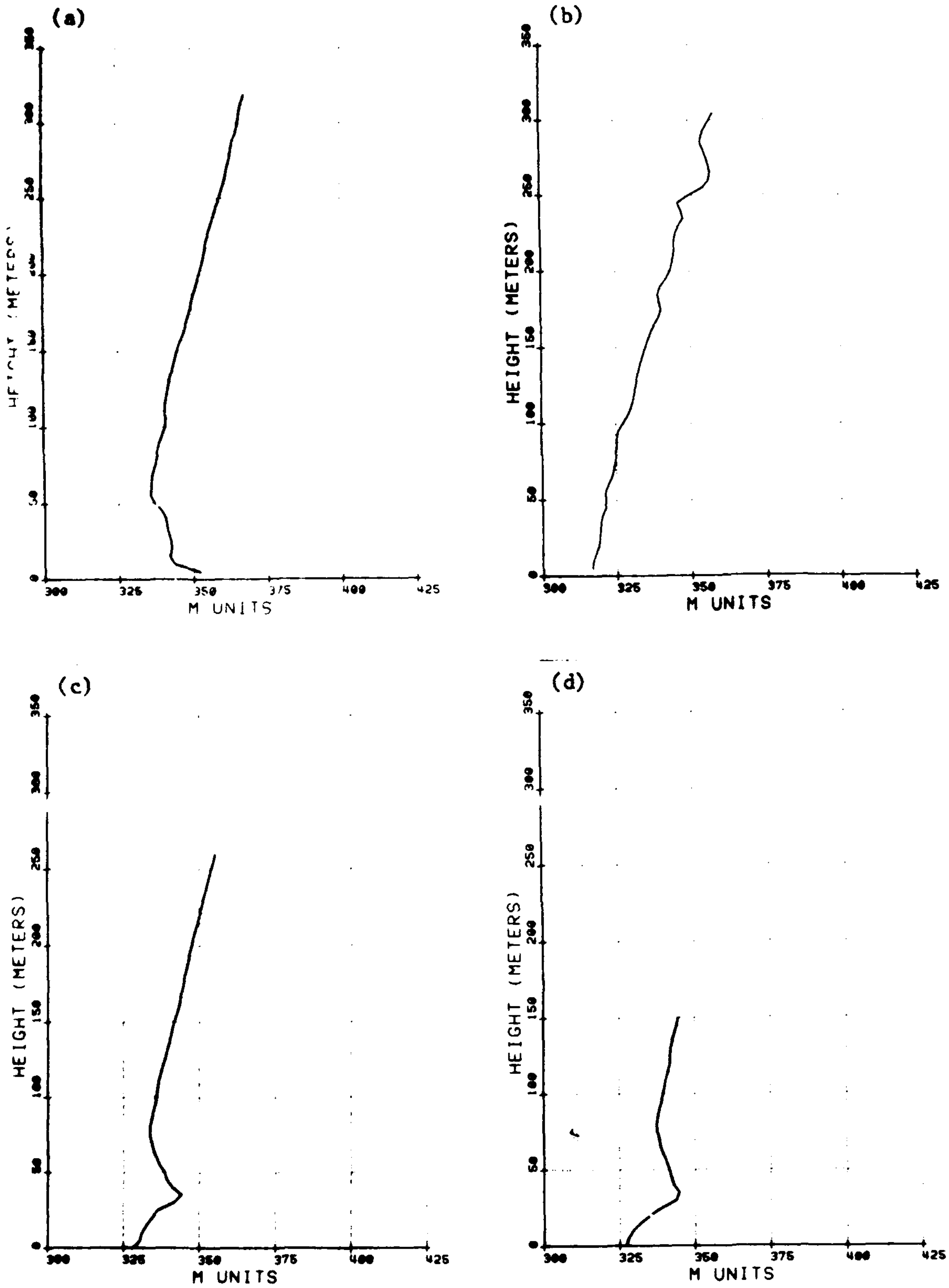


Figure 4-8 Case 4 M-Profiles: a. Apalachicola, 5 Nov 78, 1400Z; b. Apalachicola, 5 Nov 78, 1600Z; c. White City, 5 Nov 78, 0800Z; d. White City, 5 Nov 78, 1200Z.

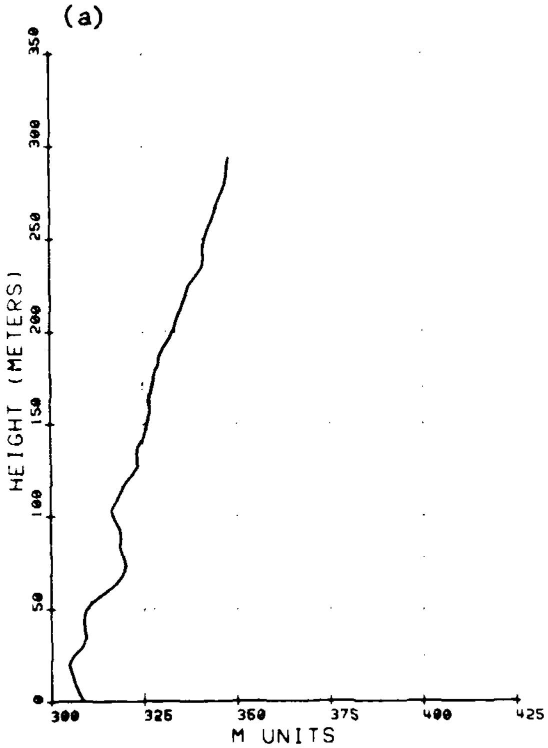


Figure 4-9 Case 4 M-Profile :
a. White City, 5 Nov 78, 1600Z.

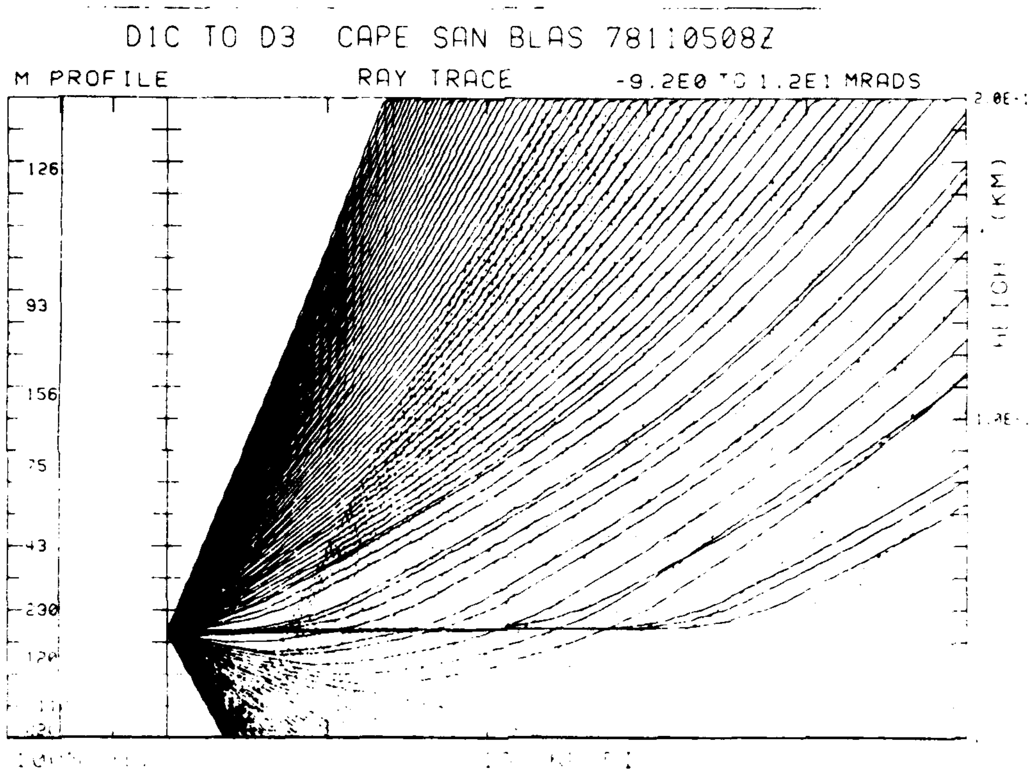


Figure 4-10. **Case 4 Raytrace, D1C to D3, Cape San Blas, 5 Nov 78, 0800Z, Transmitter Height 33.5 m.**

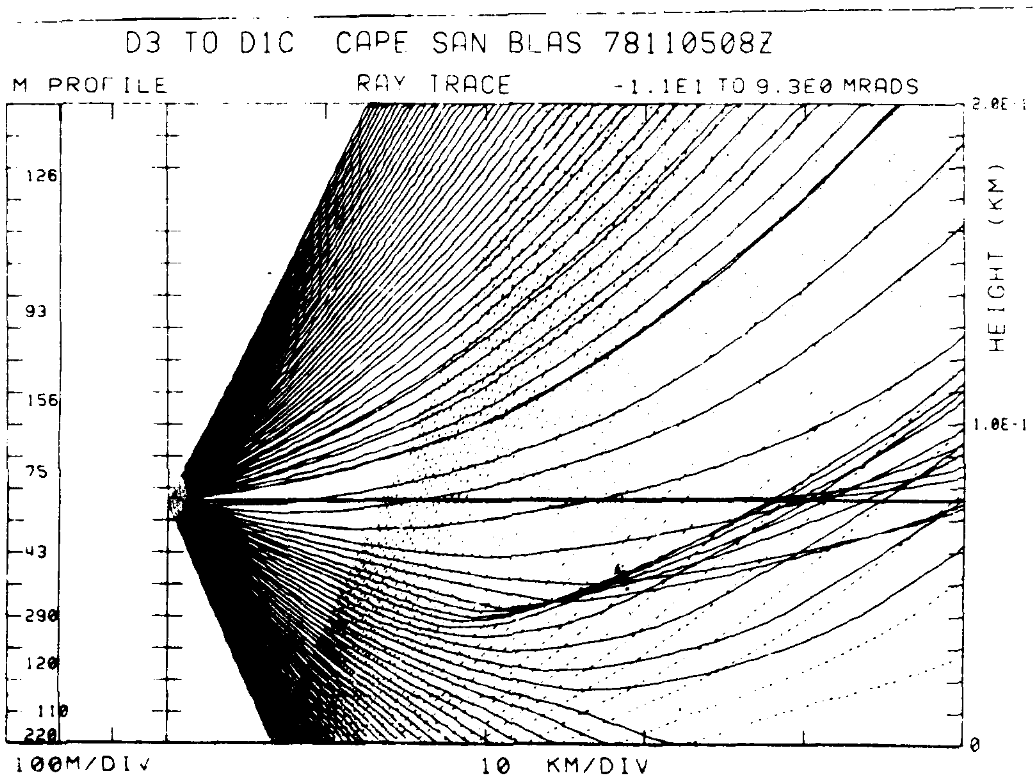


Figure 4-11. **Case 4 Raytrace, D3 to D1C, Cape San Blas, 5 Nov 78, 0800Z, Transmitter Height 76.2 m.**

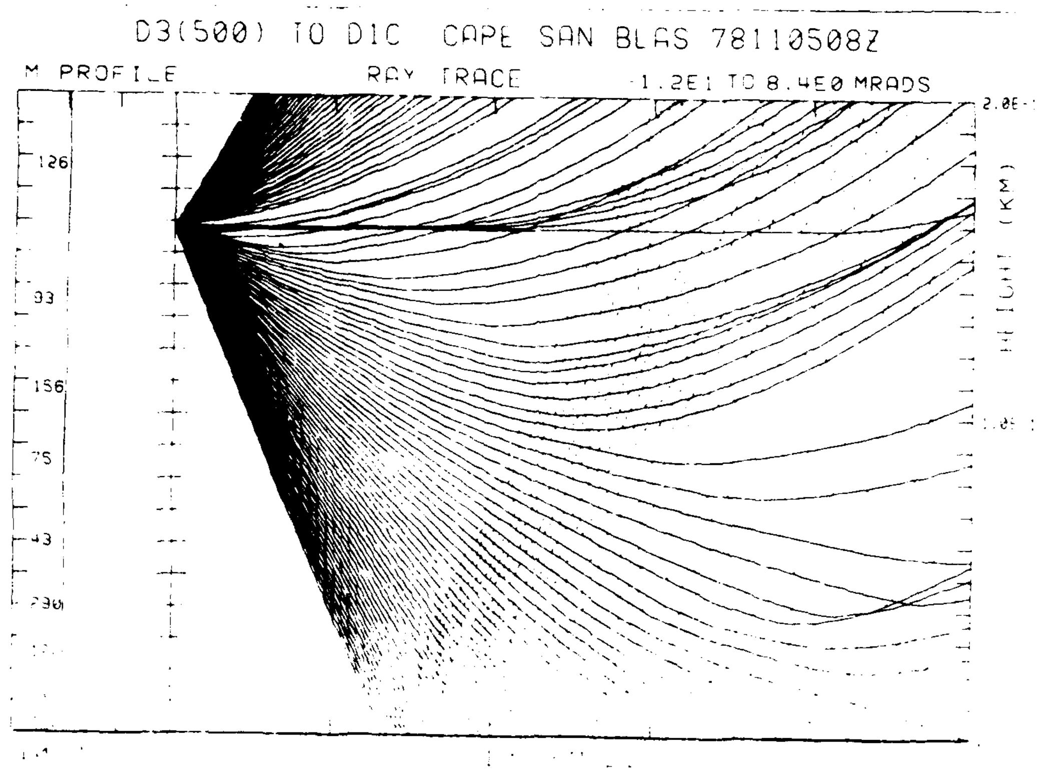


Figure 4-12. Case 4 Raytrace, D3(500) to D1C, Cape San Blas 5 Nov 78, 0800Z, Transmitter Height 158.4 m.

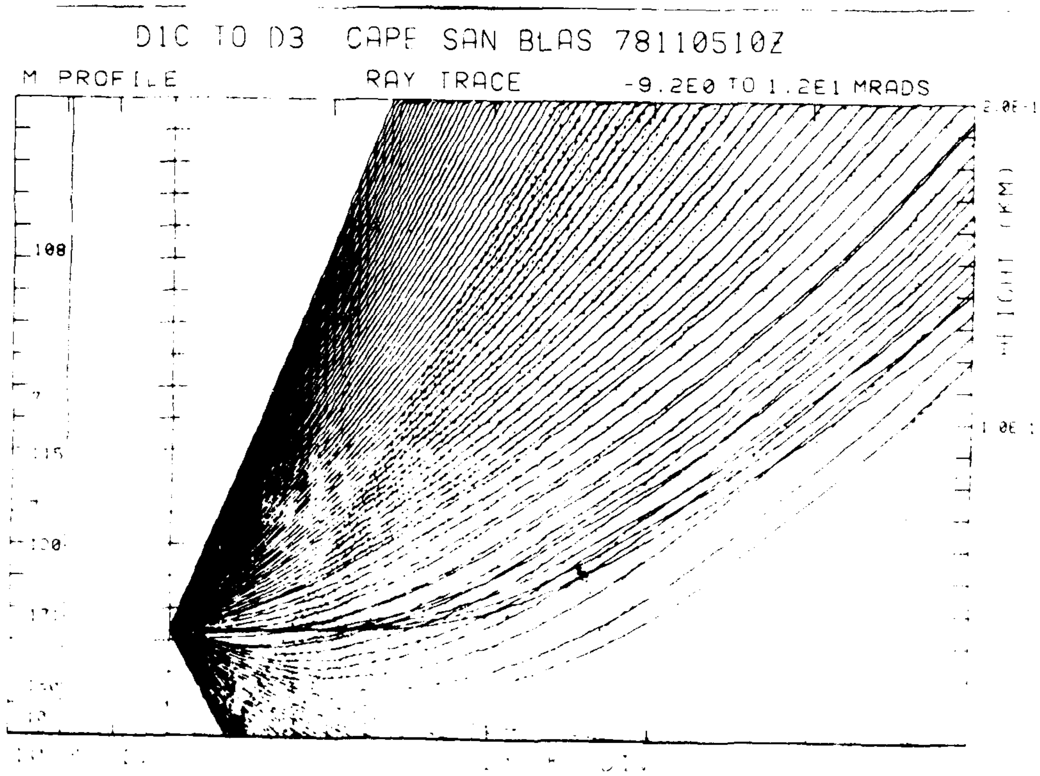


Figure 4-13. Case 4 Raytrace, D1C to D3, Cape San Blas, 5 Nov 78, 1000Z, Transmitter Height 33.5 m.

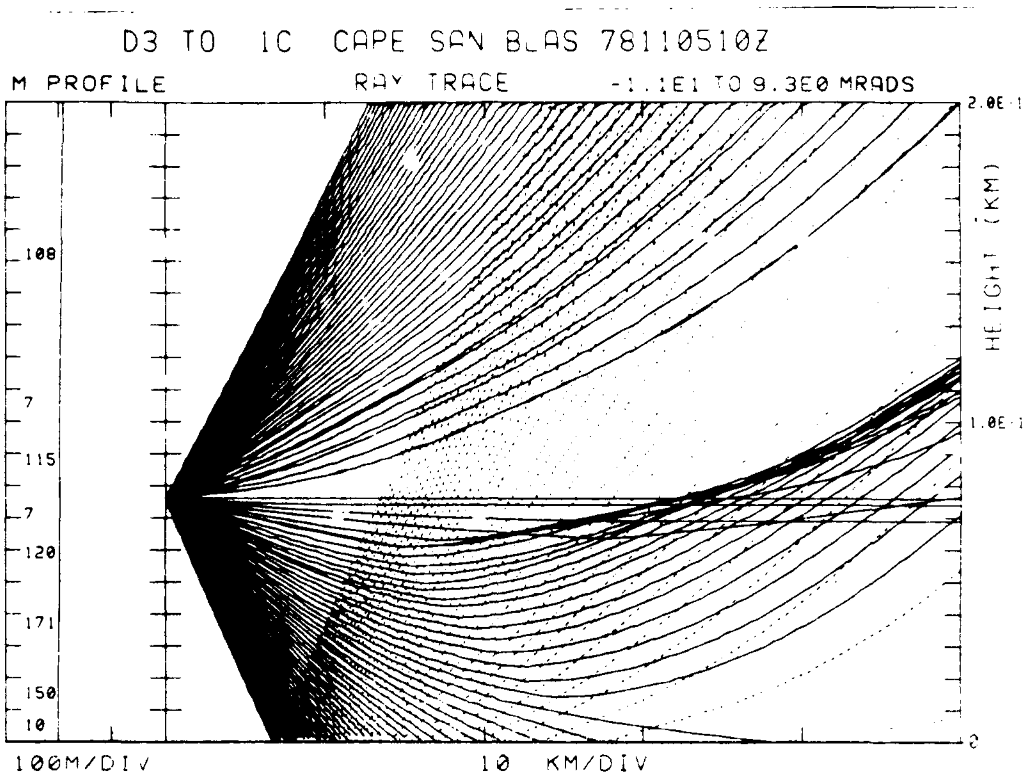


Figure 4-14. Case 4 Raytrace, D3 to D1C, Cape San Blas, 5 Nov 78, 1000Z, Transmitter Height 76.2 m.

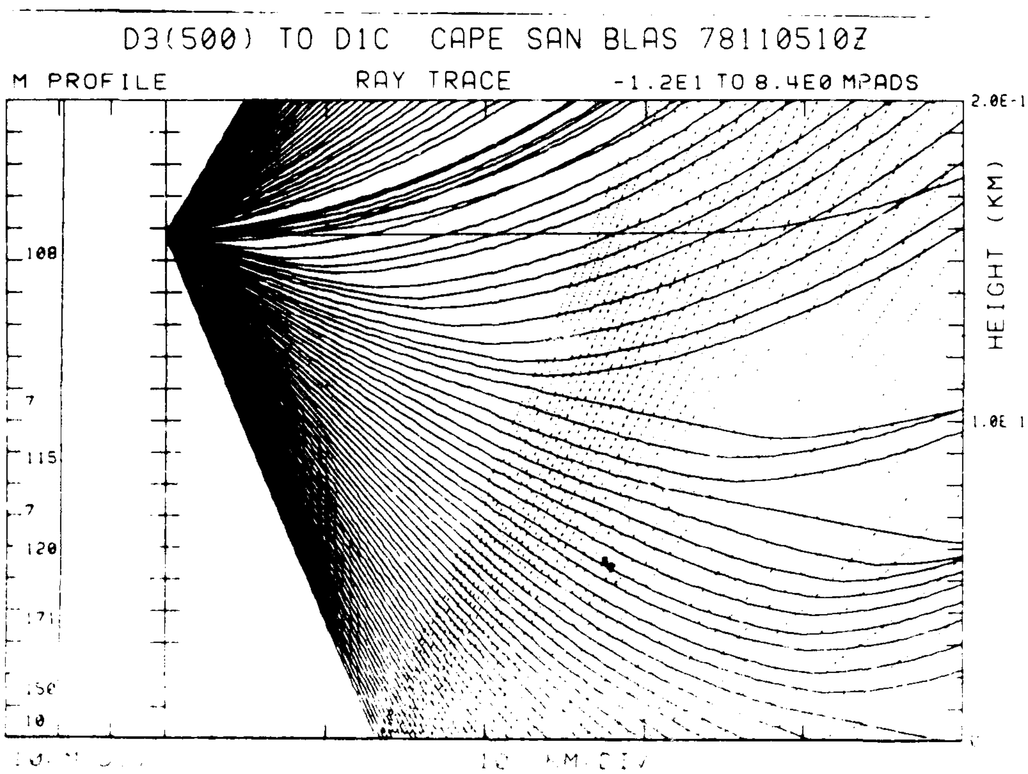


Figure 4-15. Case 4 Raytrace, D3(500) to D1C, Cape San Blas 5 Nov 78, 1000Z, Transmitter Height 158.4 m.

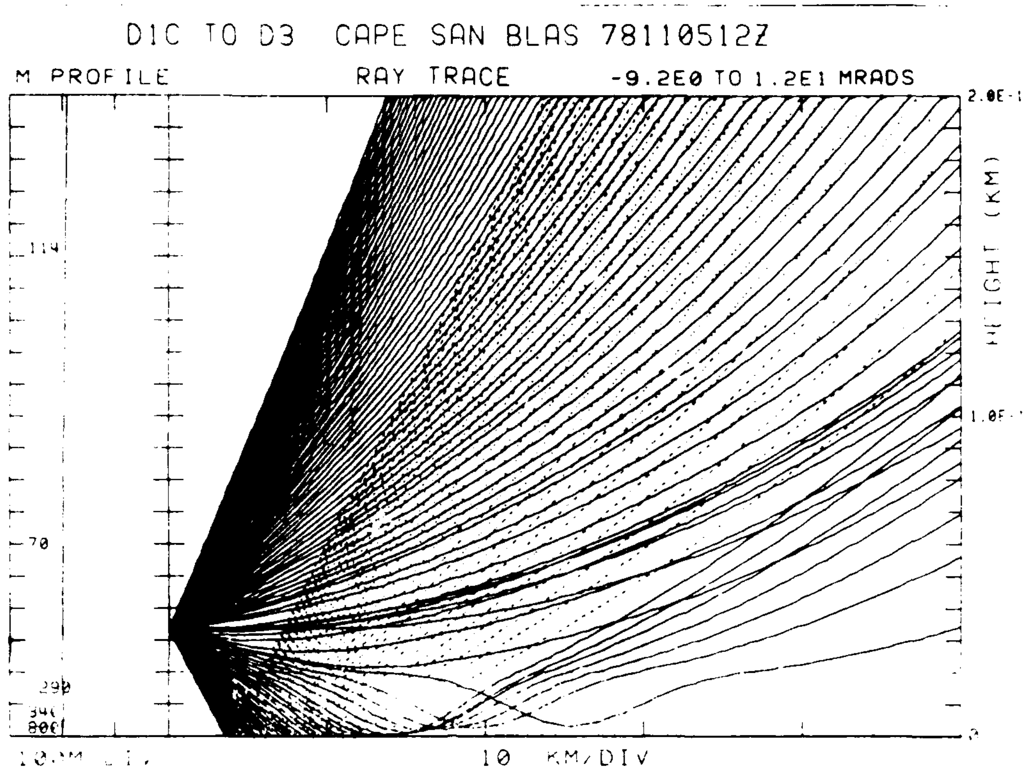


Figure 4-16. Case 4 Raytrace, D1C to D3, Cape San Blas, 5 Nov 78, 1200Z, Transmitter Height 33.5 m.

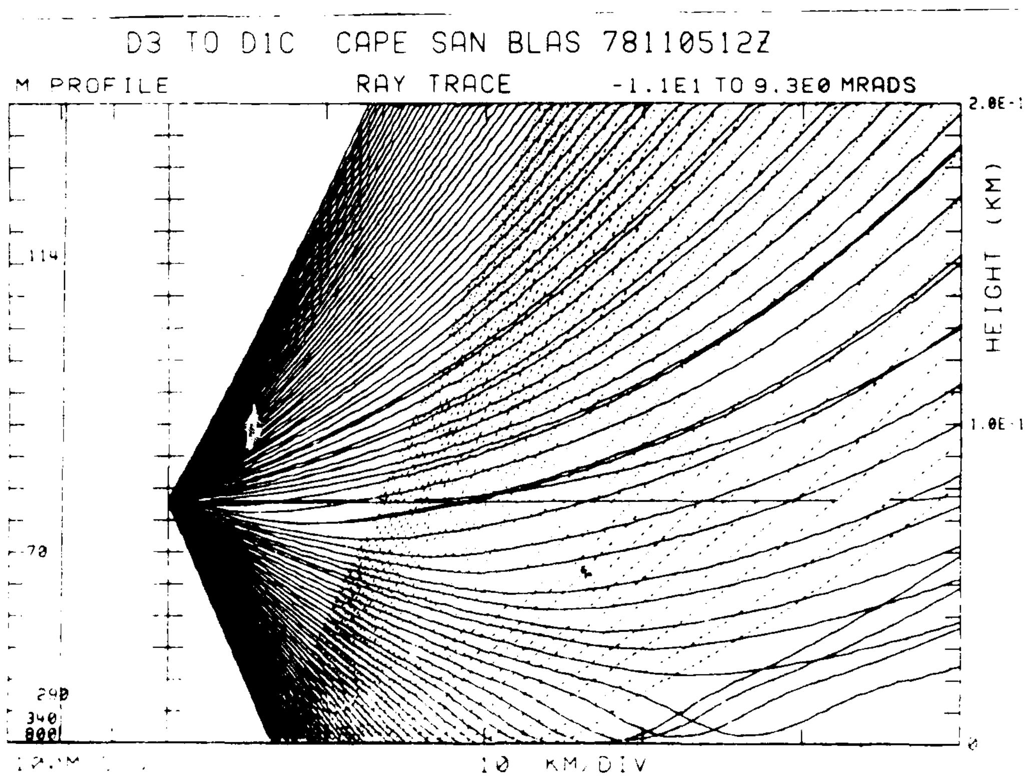


Figure 4-17. Case 4 Raytrace, D3 to D1C, Cape San Blas, 5 Nov 78, 1200Z, Transmitter Height 76.2 m.

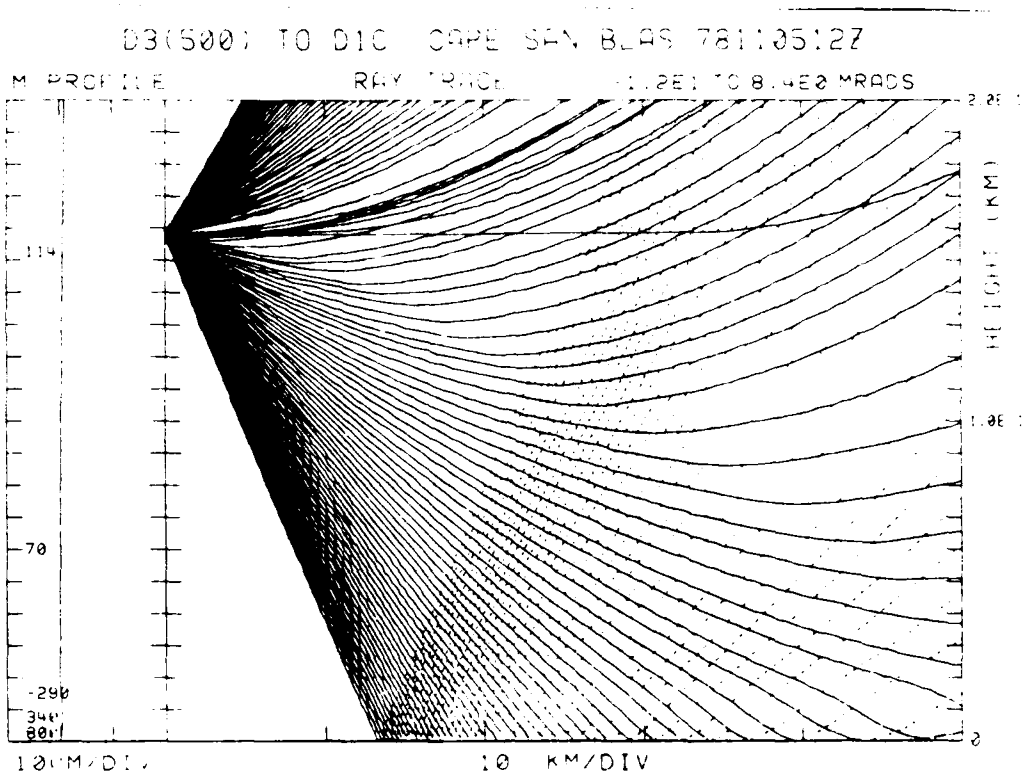


Figure 4-18. Case 4 Raytrace, D3(500) to DlC, Cape San Blas 5 Nov 78, 1200Z, Transmitter Height 158.4 m.

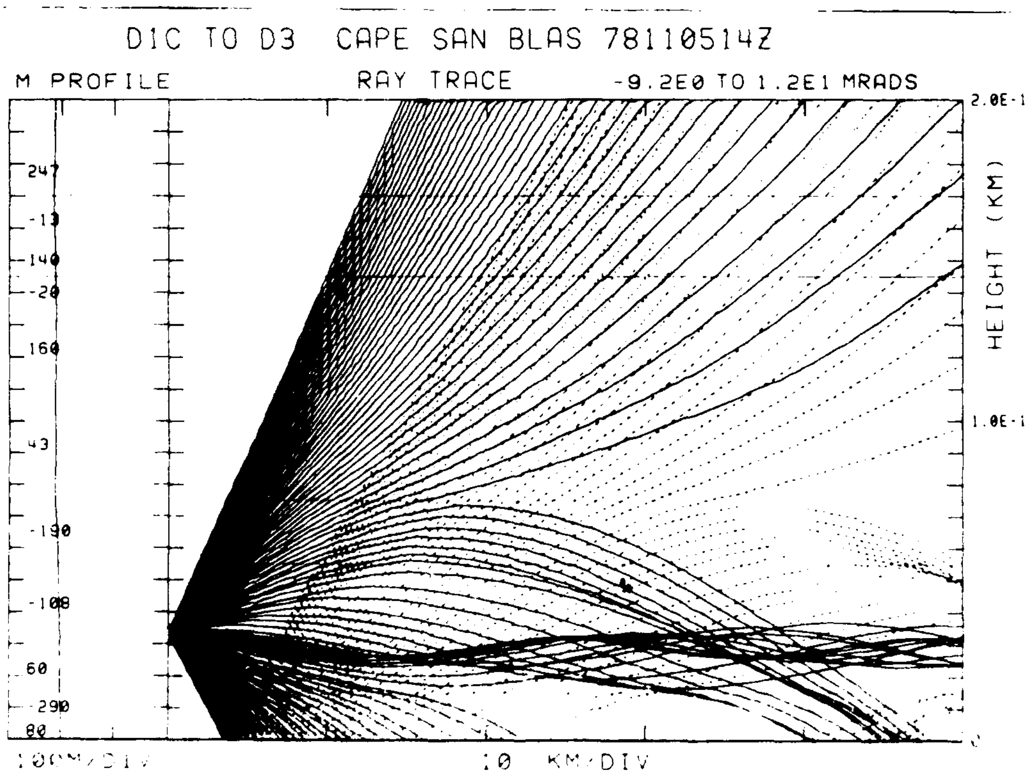


Figure 4-19. Case 4 Raytrace, DlC to D3, Cape San Blas, 5 Nov 78, 1400Z, Transmitter Height 33.5 m.

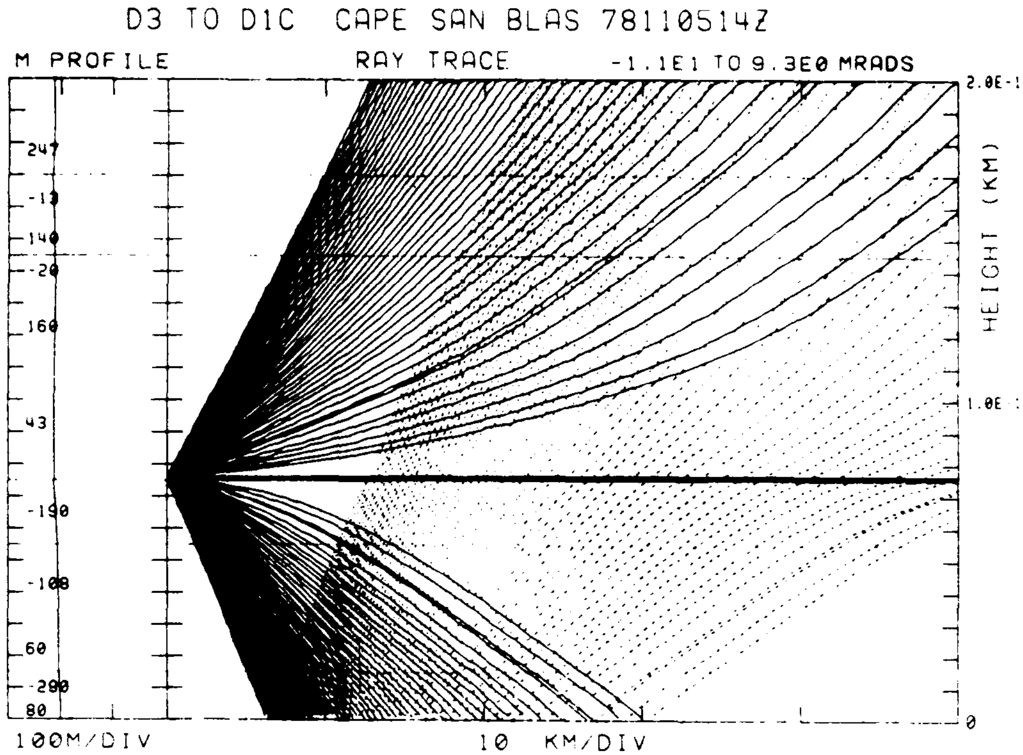


Figure 4-20. Case 4 Raytrace, D3 to D1C, Cape San Blas, 5 Nov 78, 1400Z, Transmitter Height 76.2 m.

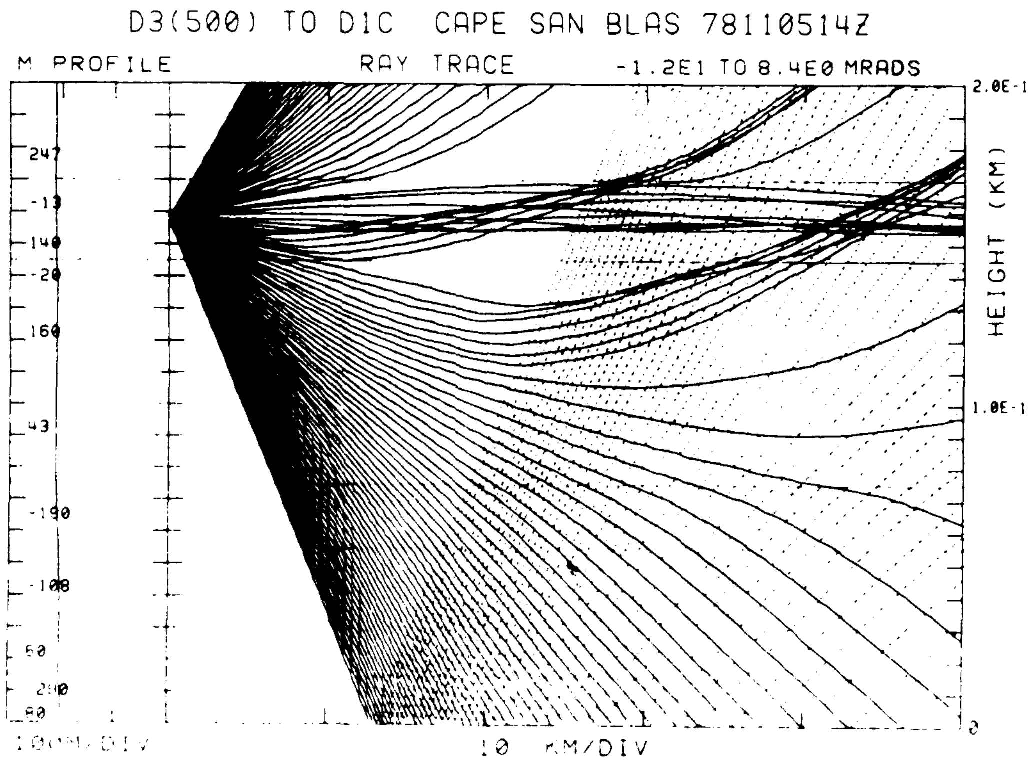


Figure 4-21. Case 4 Raytrace, D3(500) to D1C, Cape San Blas 5 Nov 78, 1400Z, Transmitter Height 158.4 m.

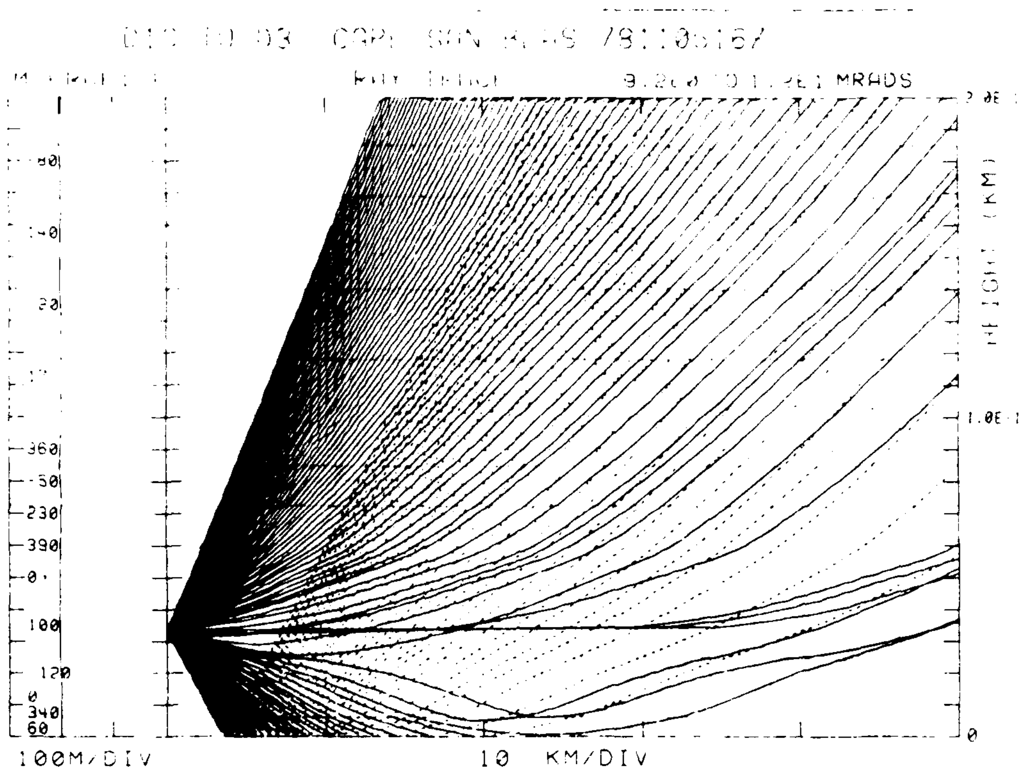


Figure 4-22. Case 4 Raytrace, D1C to D3, Cape San Blas, 5 Nov 78, 1600Z, Transmitter Height 33.5 m.

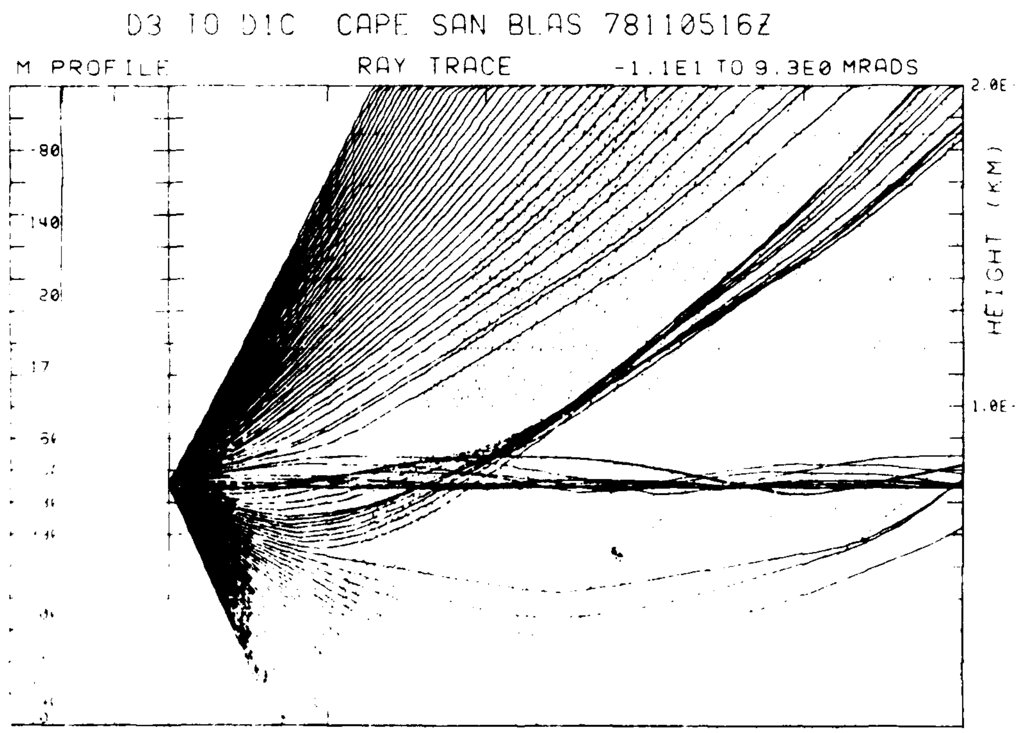


Figure 4-23. Case 4 Raytrace, D3 to D1C; Cape San Blas, 5 Nov 78, 1600Z, Transmitter Height 76.2 m.

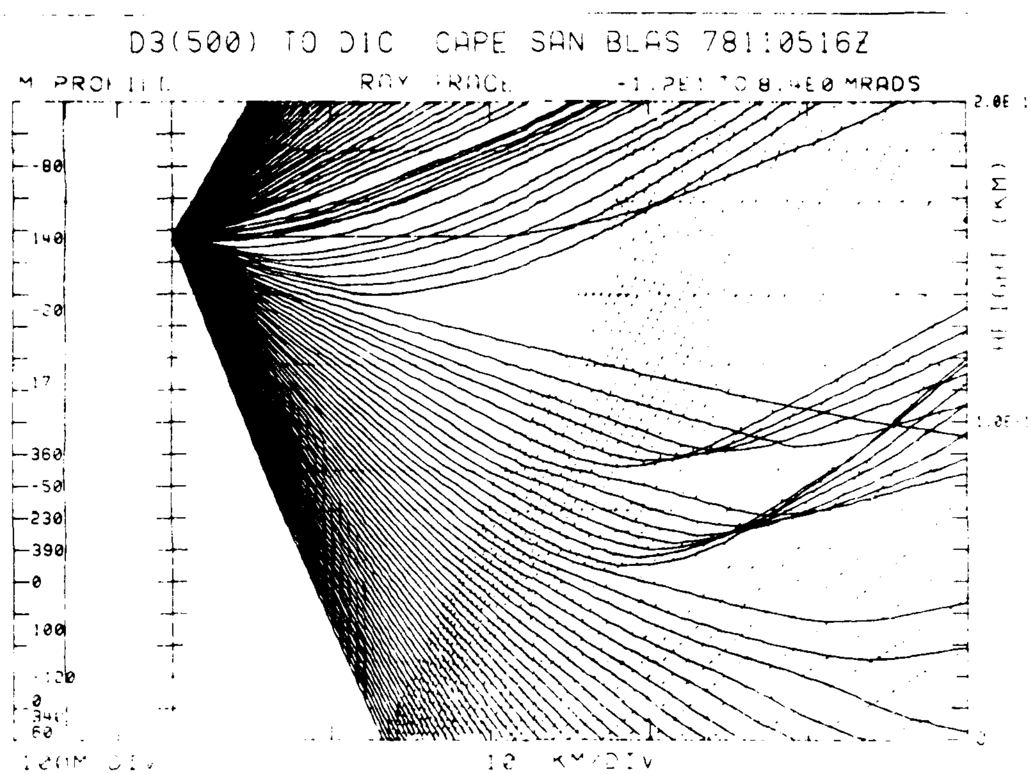


Figure 4-24. Case 4 Raytrace, D3(500) to DlC, Cape San Blas 5 Nov 78, 1600Z, Transmitter Height 158.4 m.

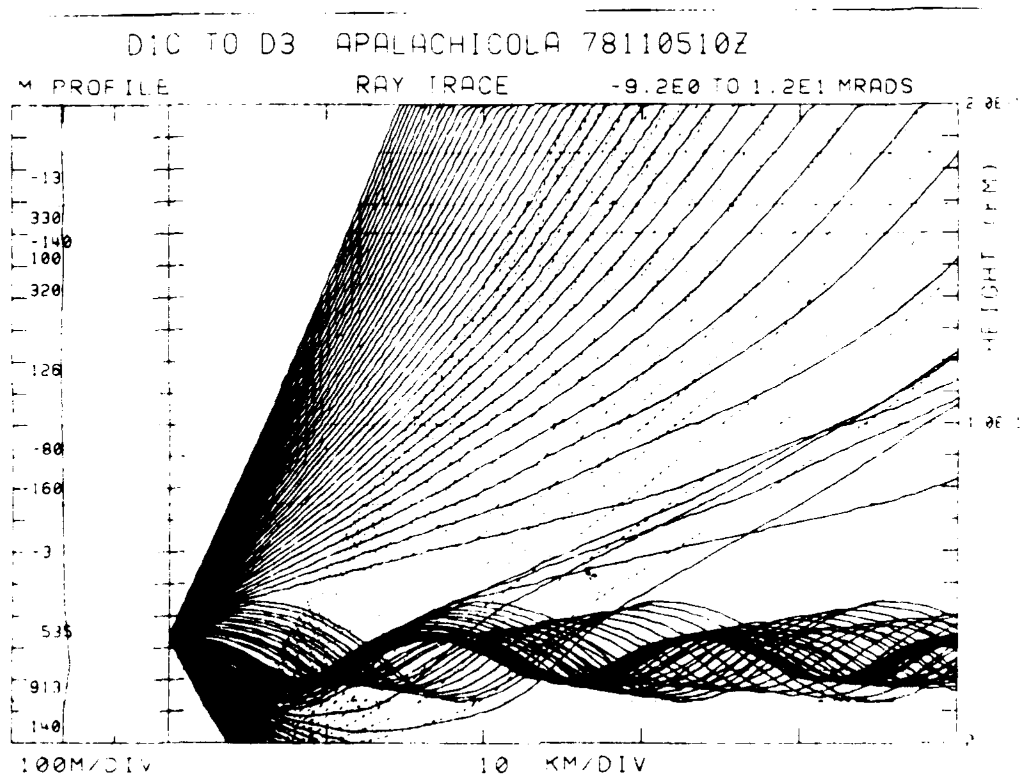


Figure 4-25. Case 4 Raytrace, DlC to D3, Apalachicola, 5 Nov 78, 1000Z, Transmitter Height 33.5 m.

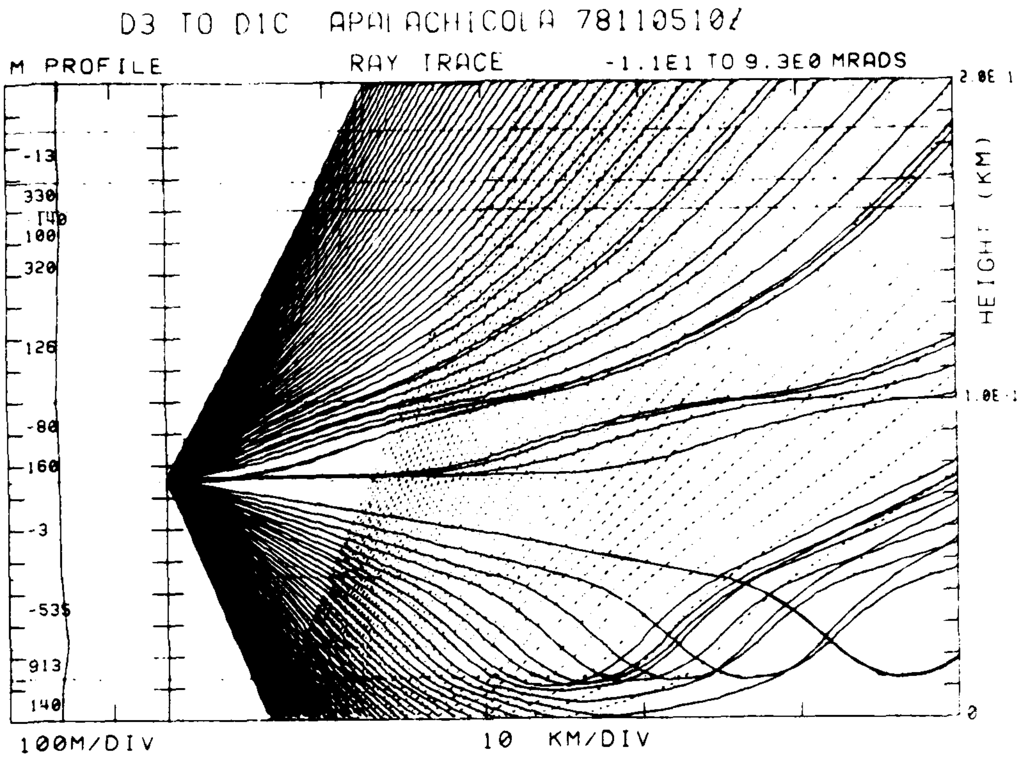


Figure 4-26. Case 4 Raytrace, D3 to D1C, Apalachicola, 5 Nov 78, 1000Z, Transmitter Height 76.2 m.

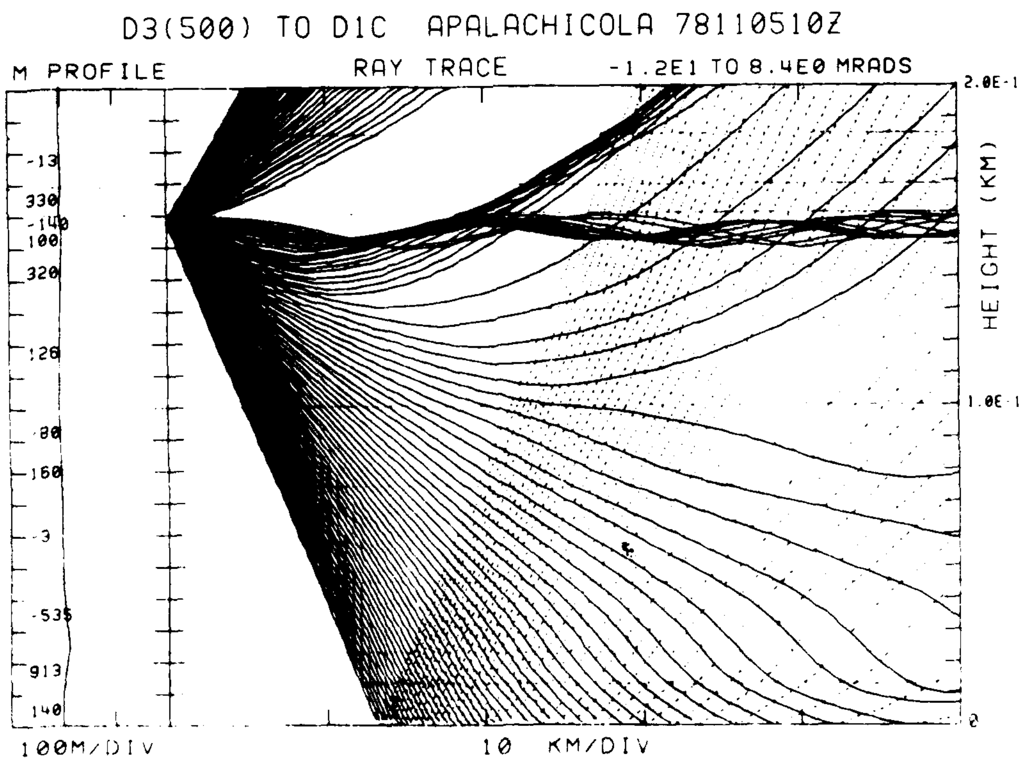


Figure 4-27. Case 4 Raytrace, D3(500) to D1C, Apalachicola 5 Nov 78, 1000Z, Transmitter Height 158.4 m.

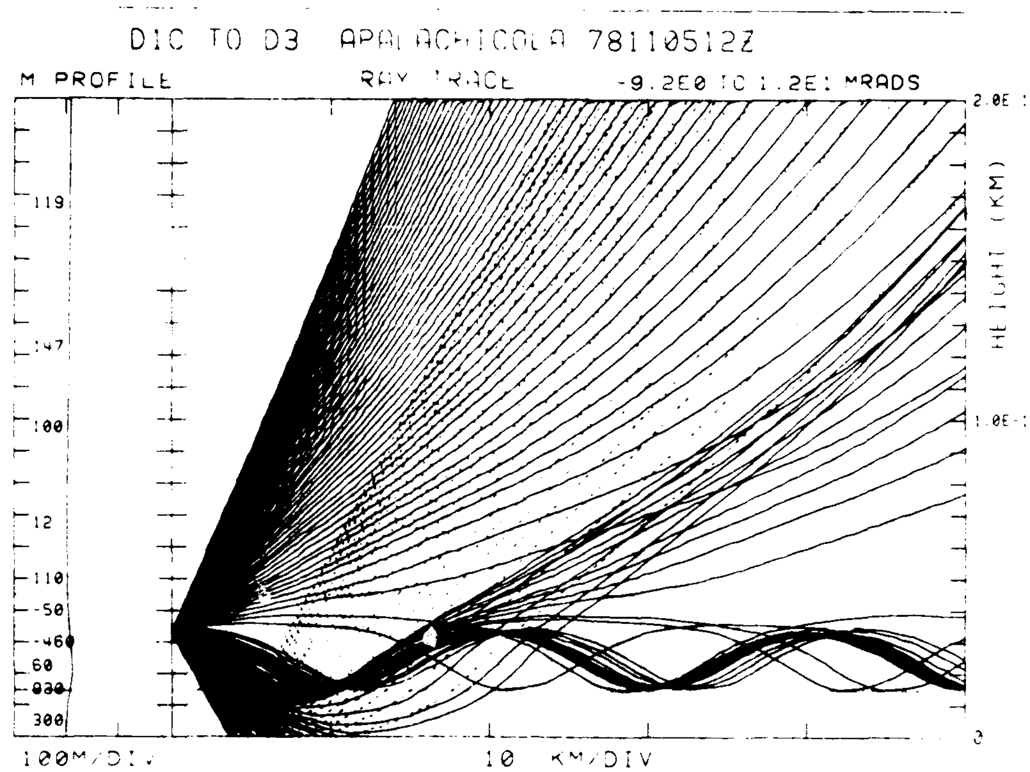


Figure 4-28. Case 4 Raytrace, D1C to D3, Apalachicola, 5 Nov 78, 1200Z, Transmitter Height 33.5 m.

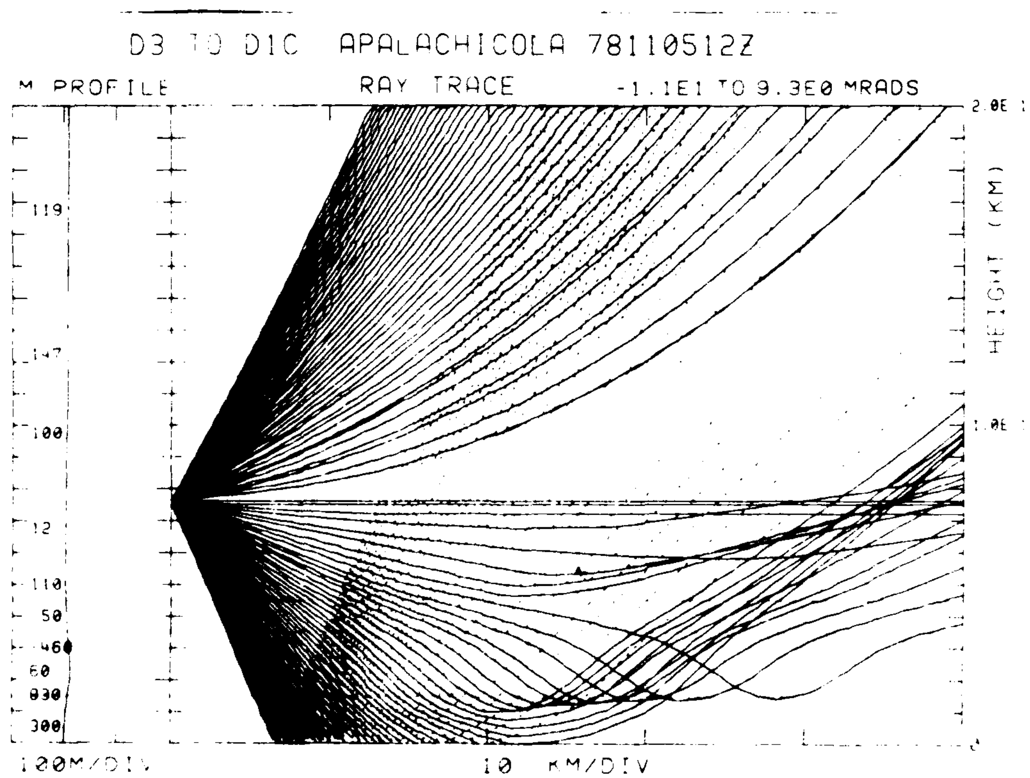


Figure 4-29. Case 4 Raytrace, D3 to D1C, Apalachicola, 5 Nov 78, 1200Z, Transmitter Height 76.2 m.

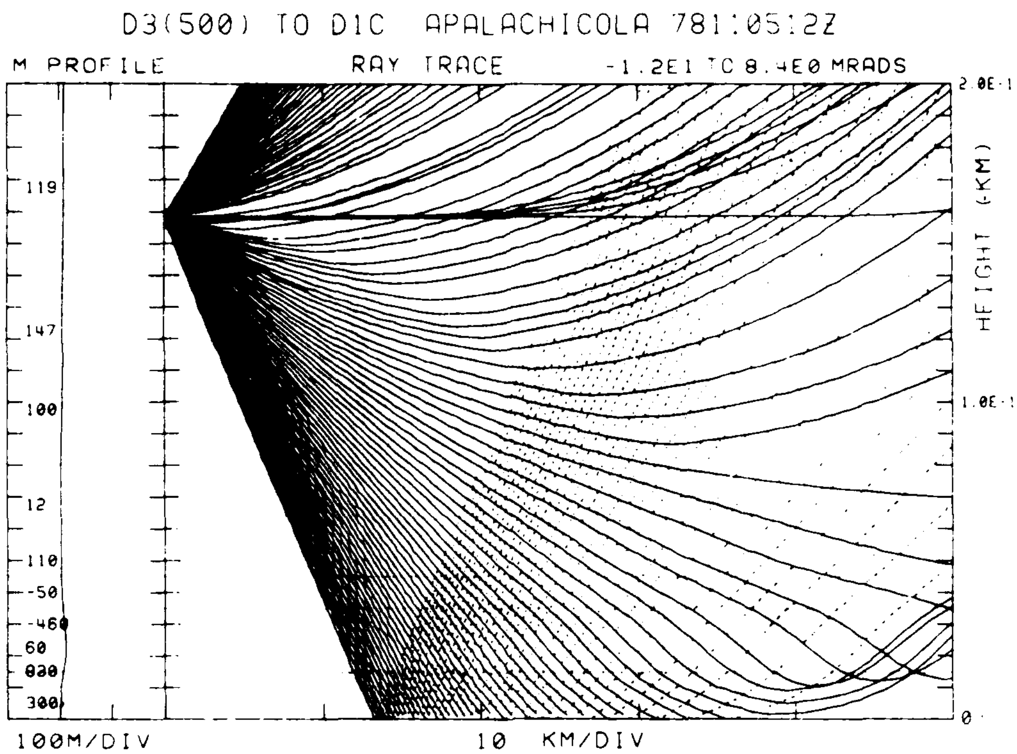


Figure 4-30. Case 4 Raytrace, D3(500) to DIC, Apalachicola 5 Nov 78, 1200Z, Transmitter Height 158.4 m.

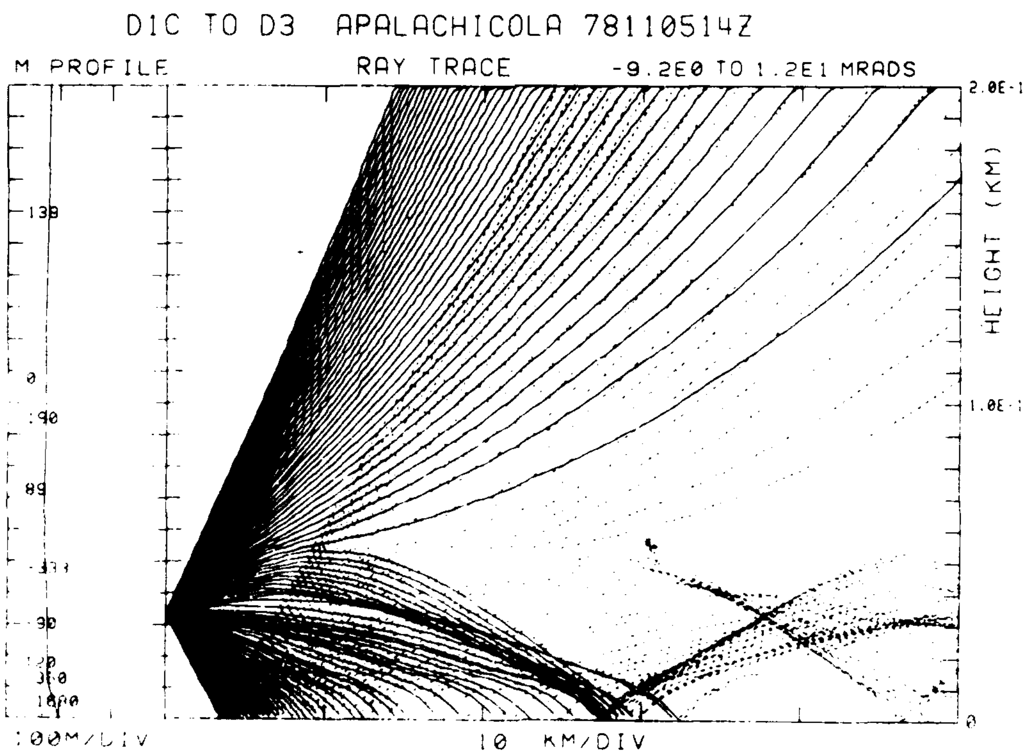


Figure 4-31. Case 4 Raytrace, DIC to D3, Apalachicola, 5 Nov 78, 1400Z, Transmitter Height 33.5 m.

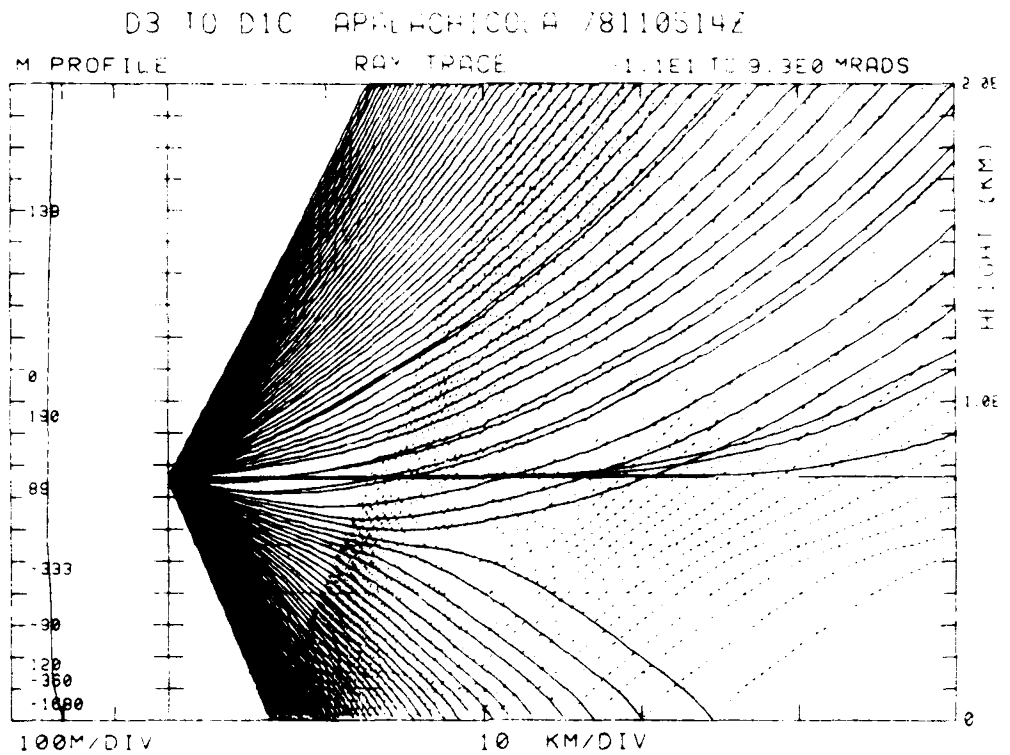


Figure 4-32. Case 4 Raytrace, D3 to DlC, Apalachicola, 5 Nov 78, 1400Z, Transmitter Height 76.2 m.

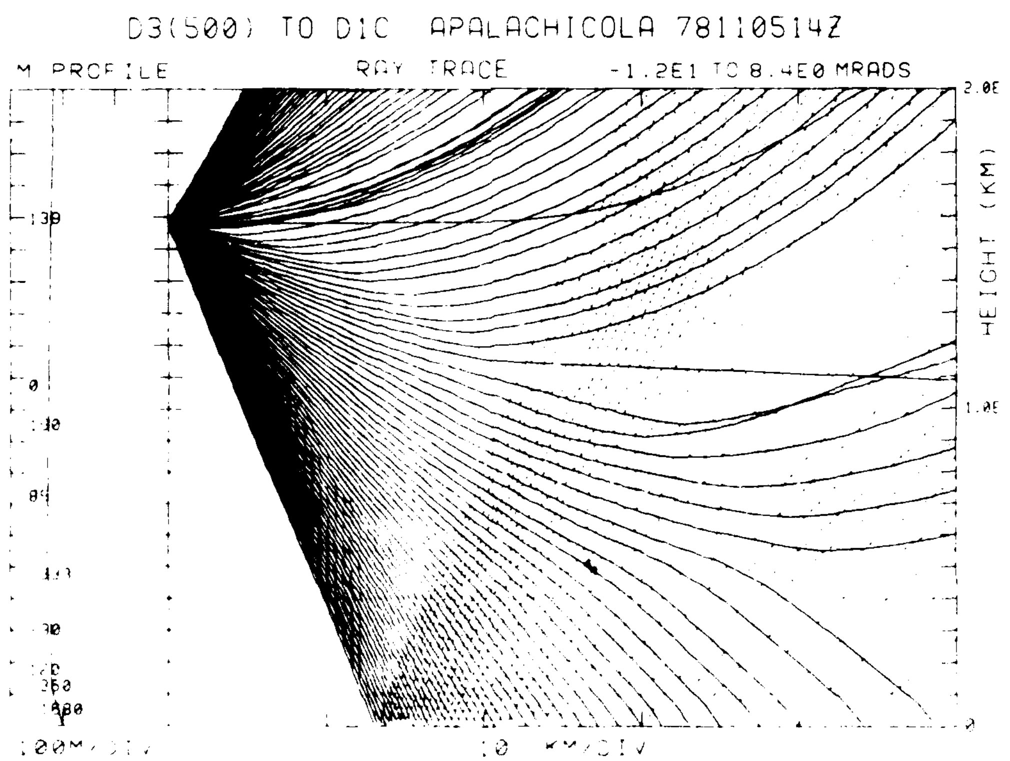


Figure 4-33. Case 4 Raytrace, D3(500) to DlC, Apalachicola 5 Nov 78, 1400Z, Transmitter Height 158.4 m.

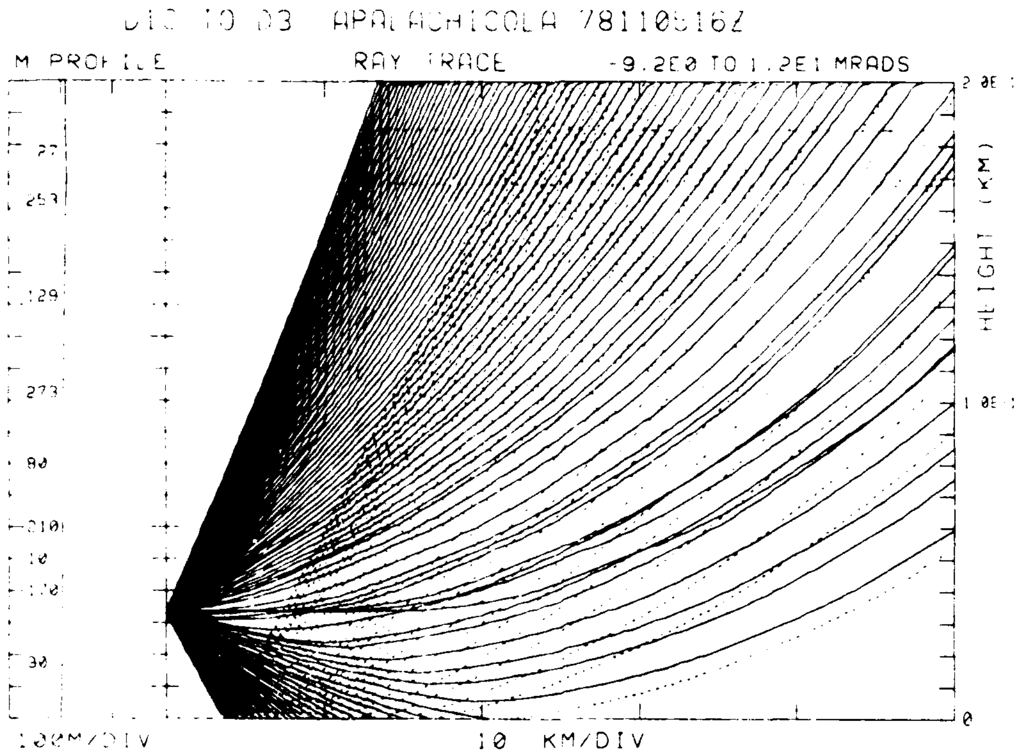


Figure 4-34. **Case 4 Raytrace, D1C to D3, Apalachicola, 5 Nov 78, 1600Z, Transmitter Height 33.5 m.**

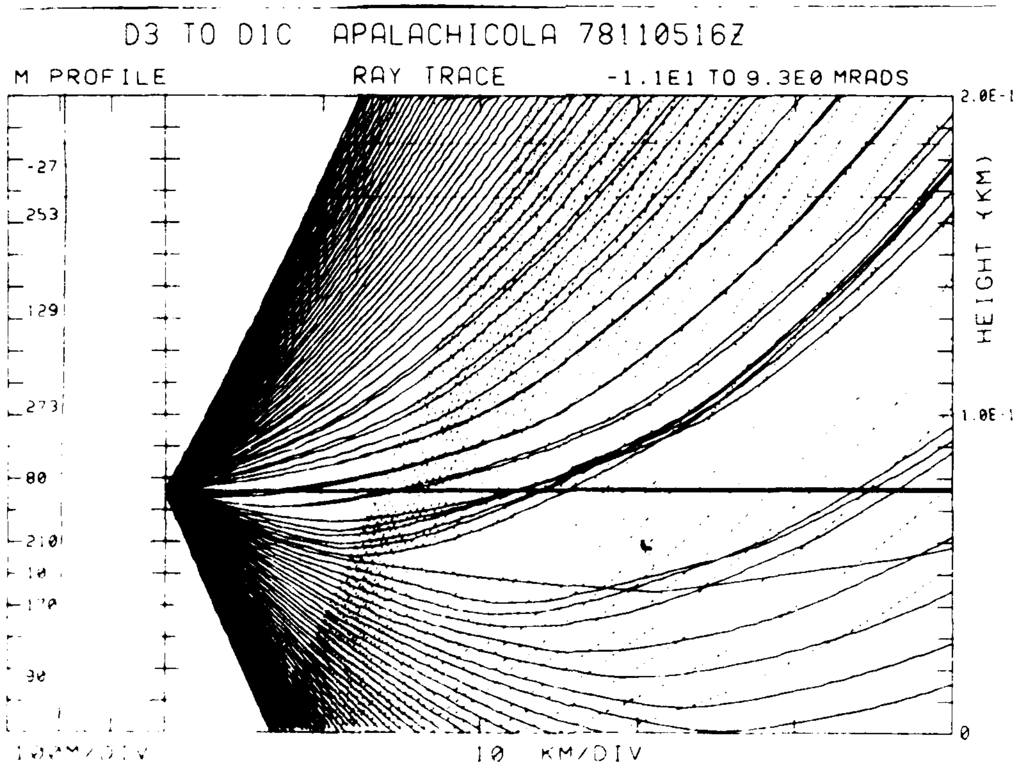


Figure 4-35. **Case 4 Raytrace, D3 to D1C, Apalachicola, 5 Nov 78, 1600Z, Transmitter Height 76.2 m.**

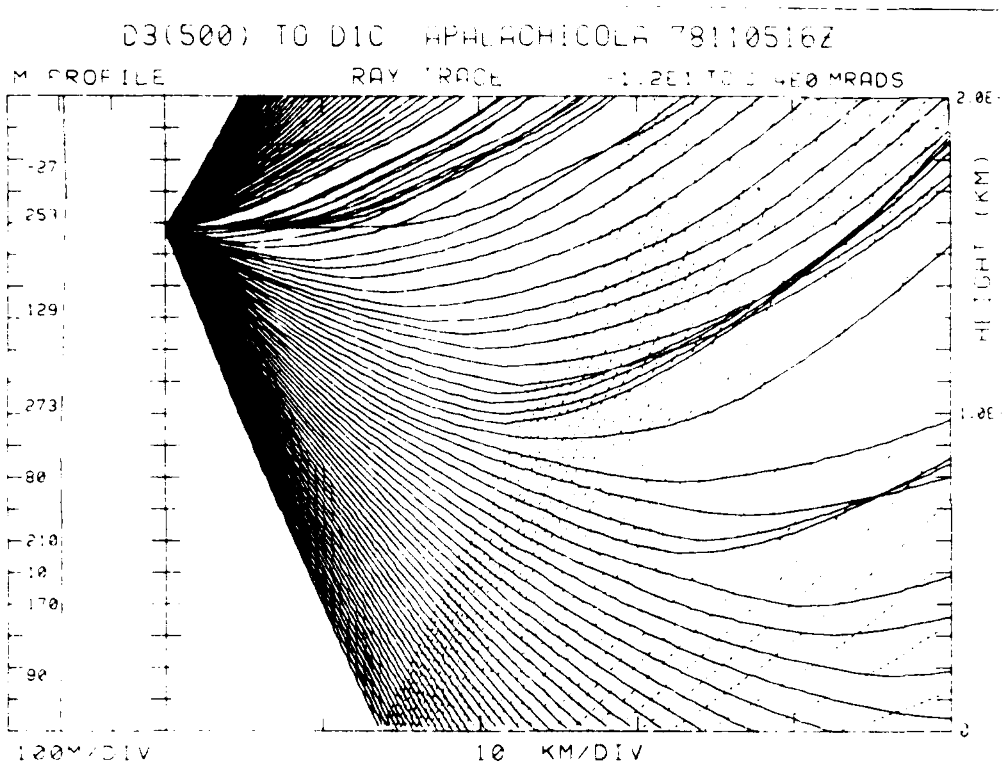


Figure 4-36. **Case 4 Raytrace, D3(500) to DlC, Apalachicola 5 Nov 78, 1600Z, Transmitter Height 158.4 m.**

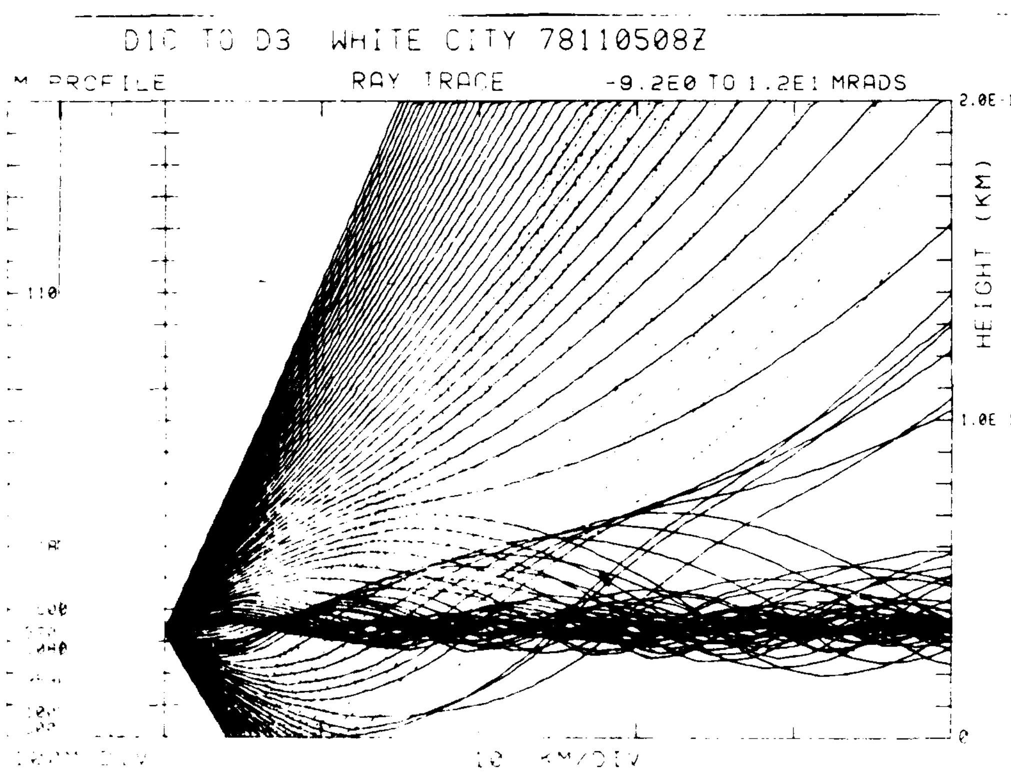


Figure 4-37. **Case 4 Raytrace, DlC to D3, White City, 5 Nov 78, 0 Z, Transmitter Height 33.5 m.**

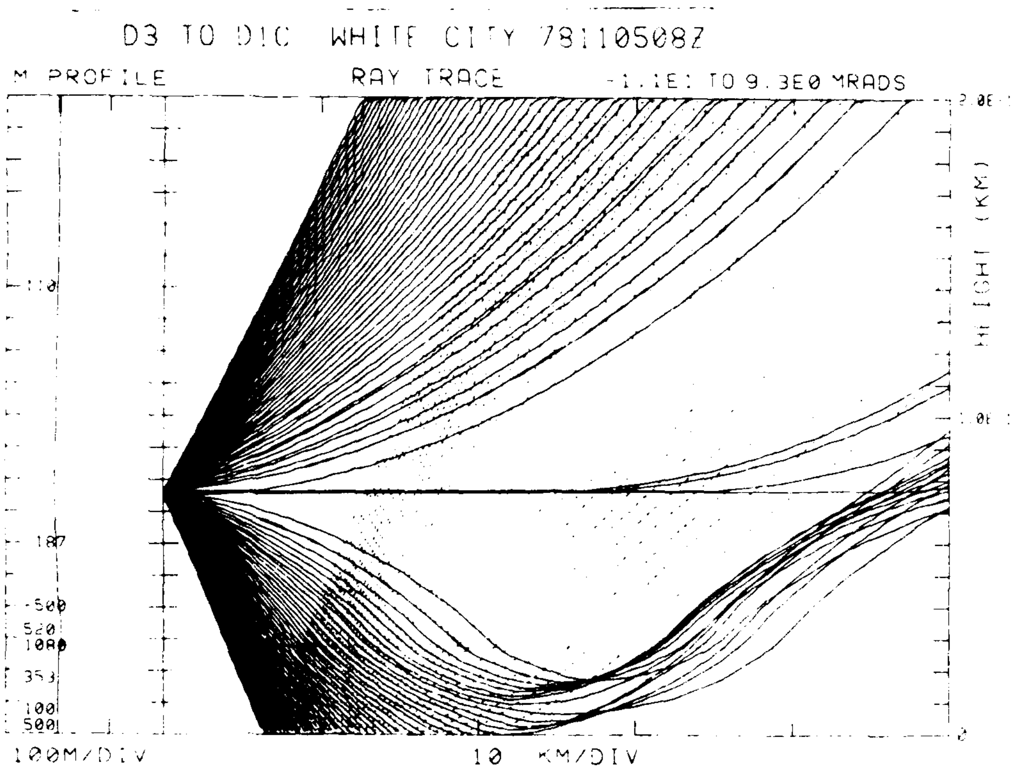


Figure 4.38. Case 4 Raytrace, D3 to D1C, White City, 5 Nov 78, 0800Z, Transmitter Height 76.2 m.

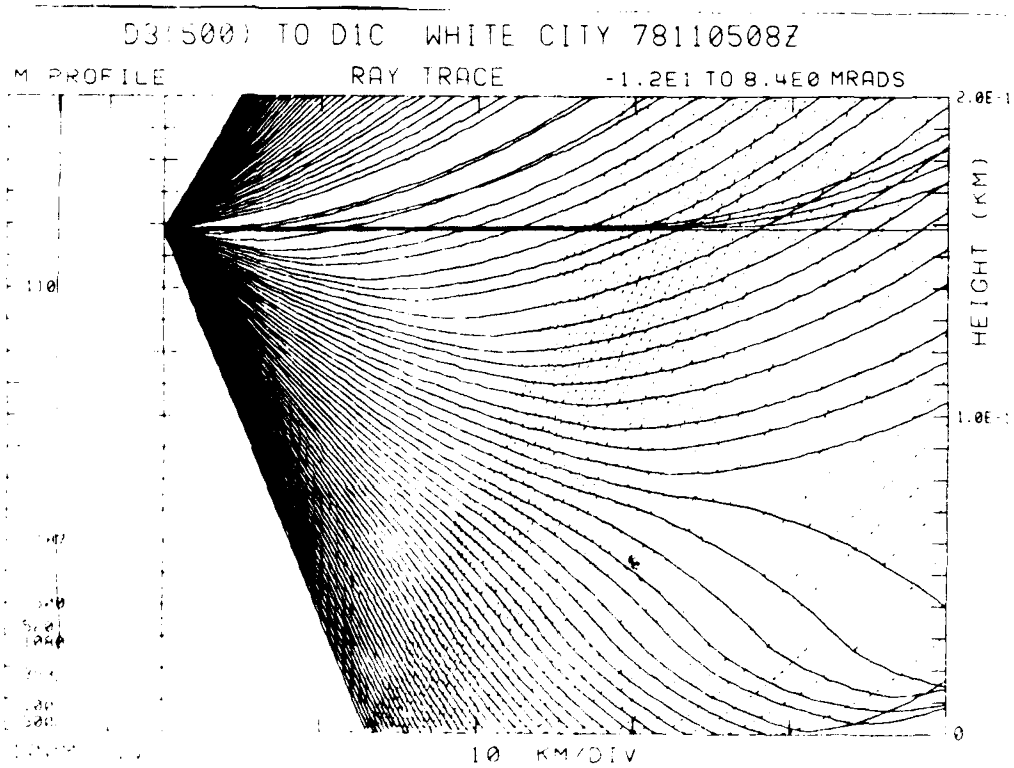


Figure 4-39. Case 4 Raytrace, D3(500) to D1C, White City 5 Nov 78, 0800Z, Transmitter Height 158.4 m.

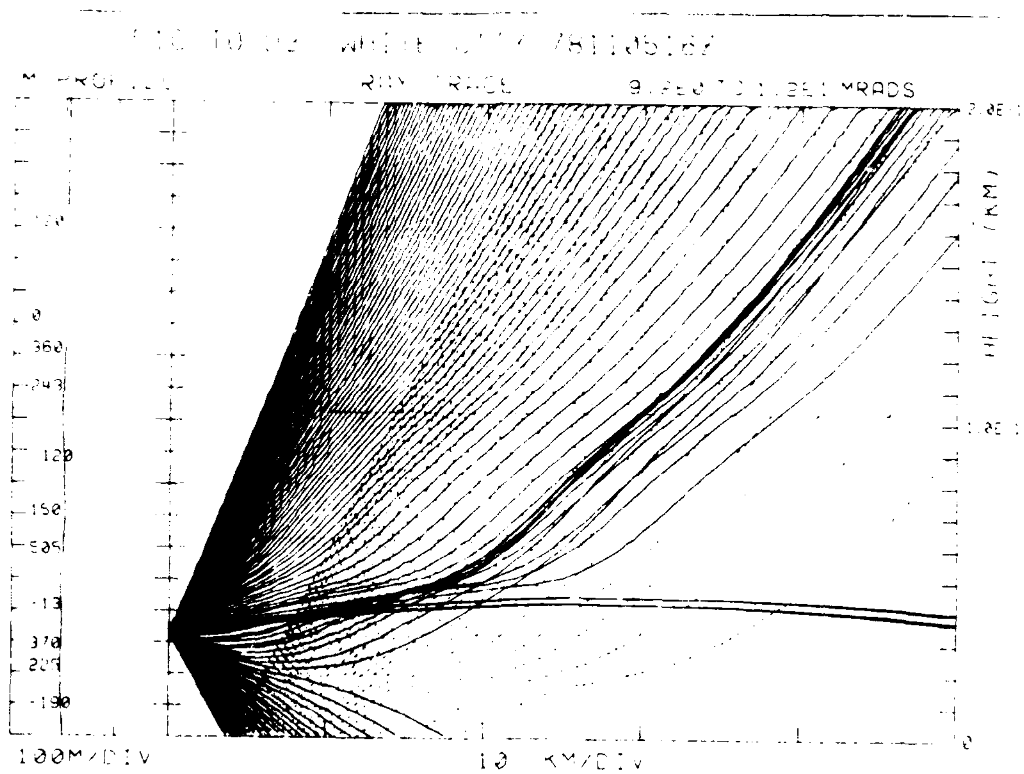


Figure 4-40. Case 4 Raytrace, D1C to D3, White City, 5 Nov 78, 1600Z, Transmitter Height 33.5 m.

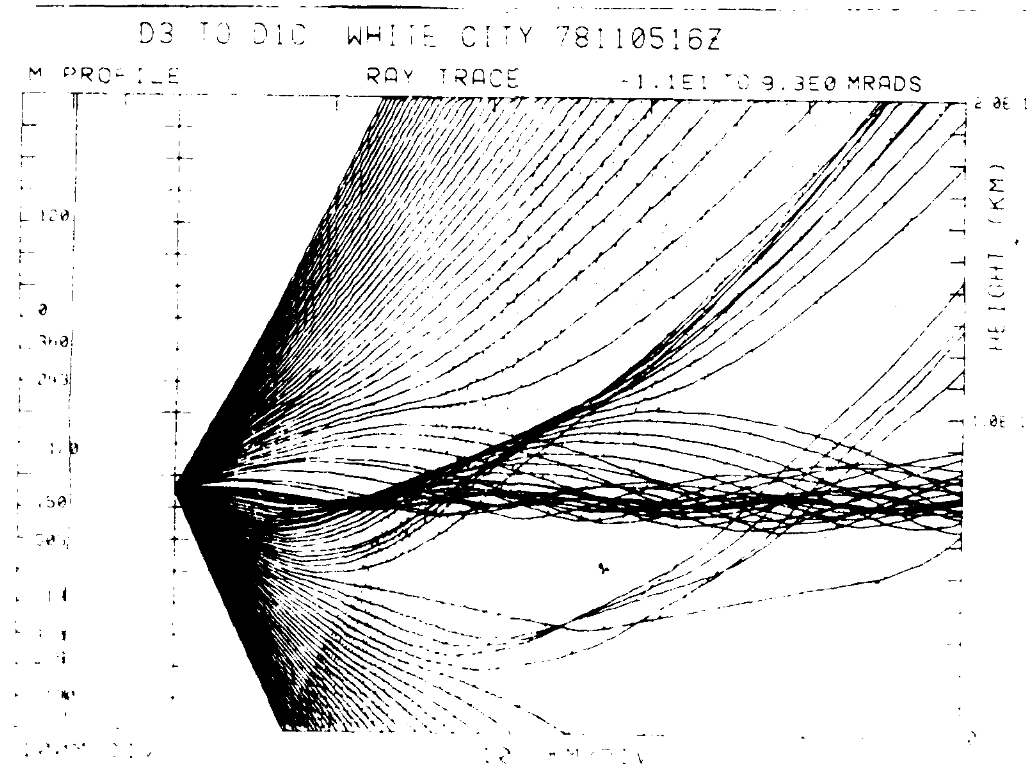


Figure 4-41. Case 4 Raytrace, D3 to D1C, White City, 5 Nov 78, 1600Z, Transmitter Height 76.2 m.

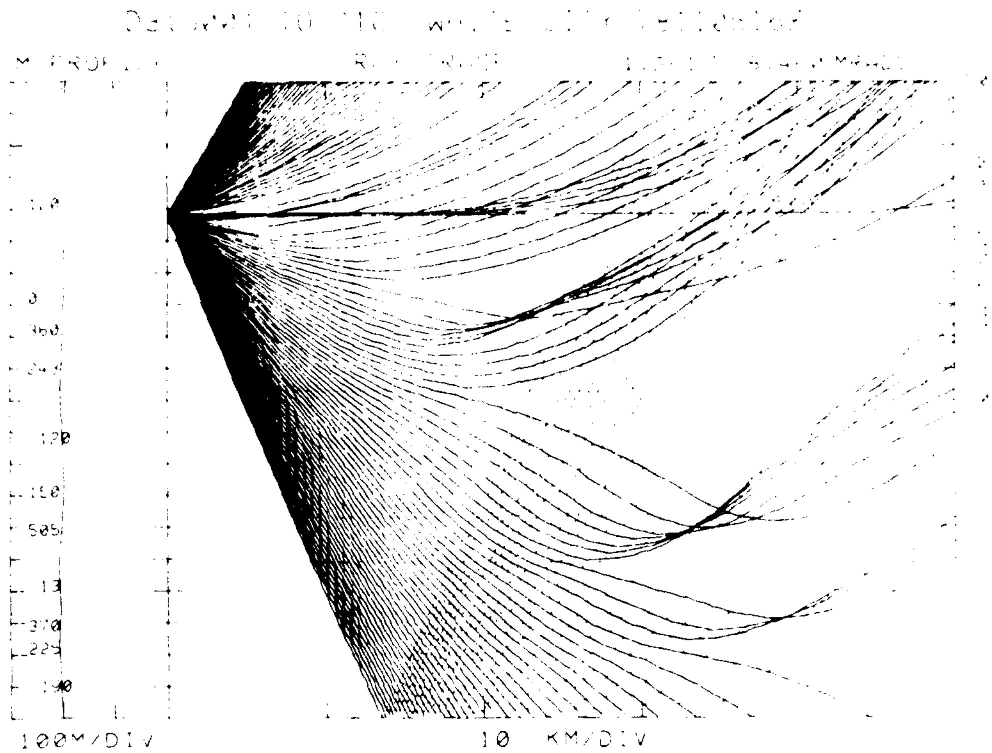


Figure 4-42. Case 4 Raytrace, D3(500) to D1C, White City
5 Nov 78, 1600Z, Transmitter Height 158.4 m.

CASE 5

1. Case 5 (12 Nov/09-15Z) is the first examination of the D3-APA path. Figure 5-1 shows a representative RSL recorded at APA. As for the D1C-D3 path, the D3-APA path also has a computed free-space RSL of -36 dbm and a computed FM threshold of -80 dbm for both receiver sites and both channels at each site.

2. Figures 5-2 and 5-3 indicate the increasingly prevalent synoptic situation of weak pressure gradient, no precipitation, light-to-calm surface winds, and some early morning fog and/or haze visibility restrictions.

3. Tables 5-1 through 5-3 show the local surface conditions to be expected with the synoptic pattern given. Visibility restrictions for this case (and previous cases) are probably due to surface radiation cooling since clear skies also seem to be prevalent.

4. M-profiles for Cape San Blas and Apalachicola are plotted in Figures 5-4 through 5-6. The Cape San Blas profiles indicate a fairly obvious "breakpoint" between abnormal refraction, or fluctuating values of M, and more normal refraction at about 100-150 meters. This also seems true for the Apalachicola profiles, except that the breakpoints occur nearer the 200-meter level. This breakpoint seems to represent a level that defines decoupling between the boundary layer and the higher portion of the atmosphere that is strongly mixed and influenced by the higher synoptic airflows.

5. Raytraces for all M-profiles, using the existing and 158.4-meter antenna heights, are shown in Figures 5-5 through 5-36. The direct-ray pattern again improves consistently when the 158.4-meter antenna is used.

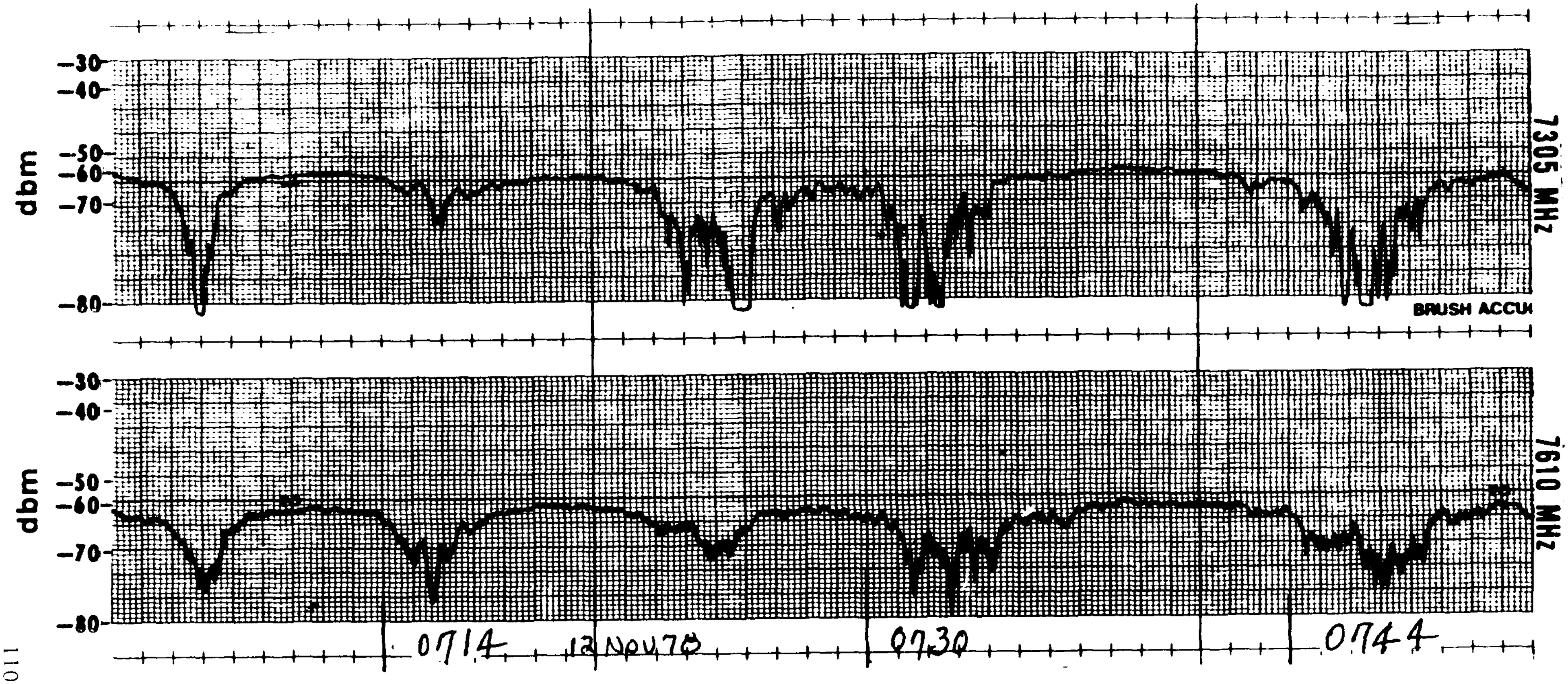


Figure 5-1 Case 5 RSL Strip Chart showing typical fade pattern on both channels of APA received from D3. Times are from 0705 EST to 0752, 12 Nov 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

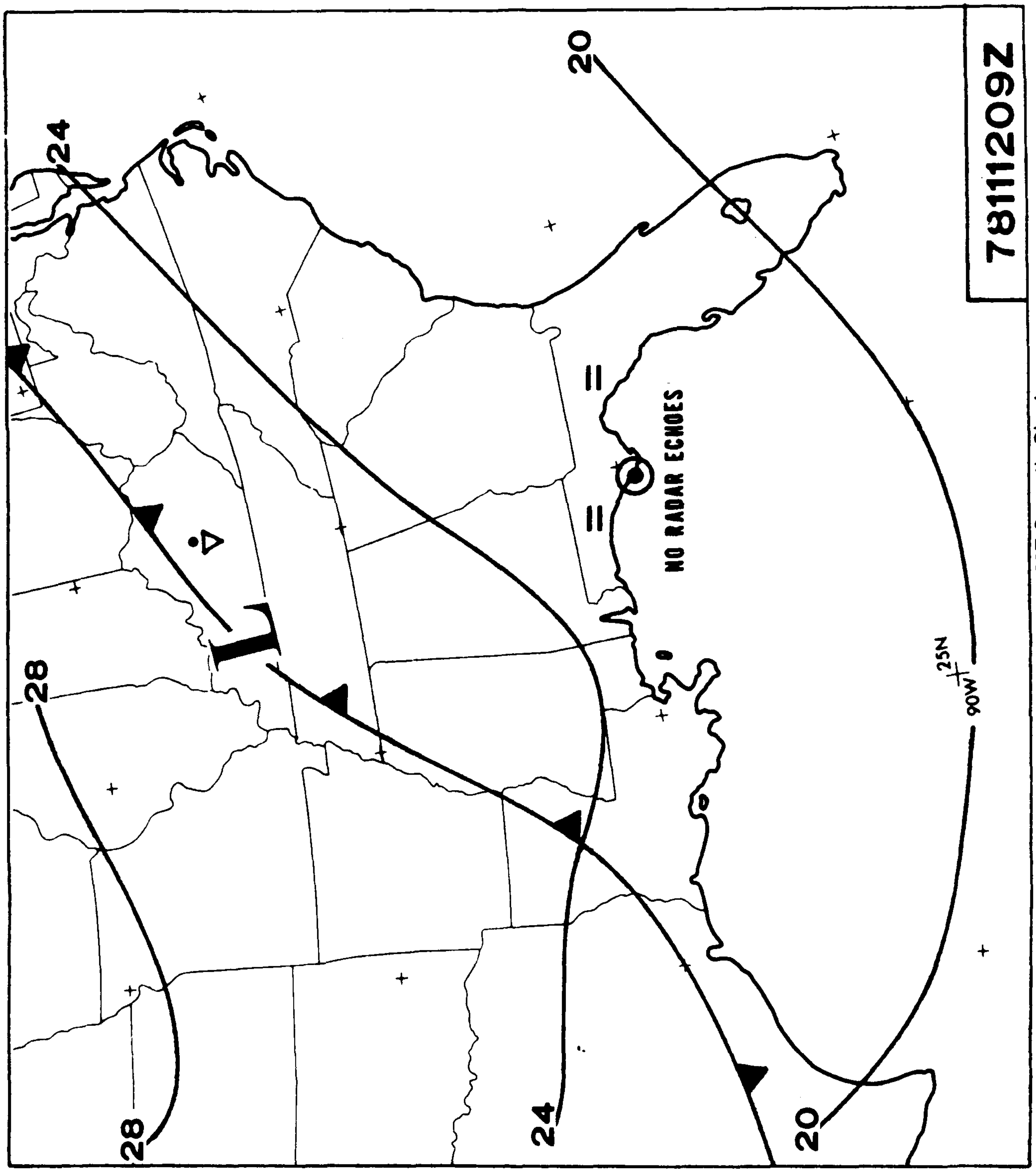


Figure 5-2 78111209Z Synoptic Chart

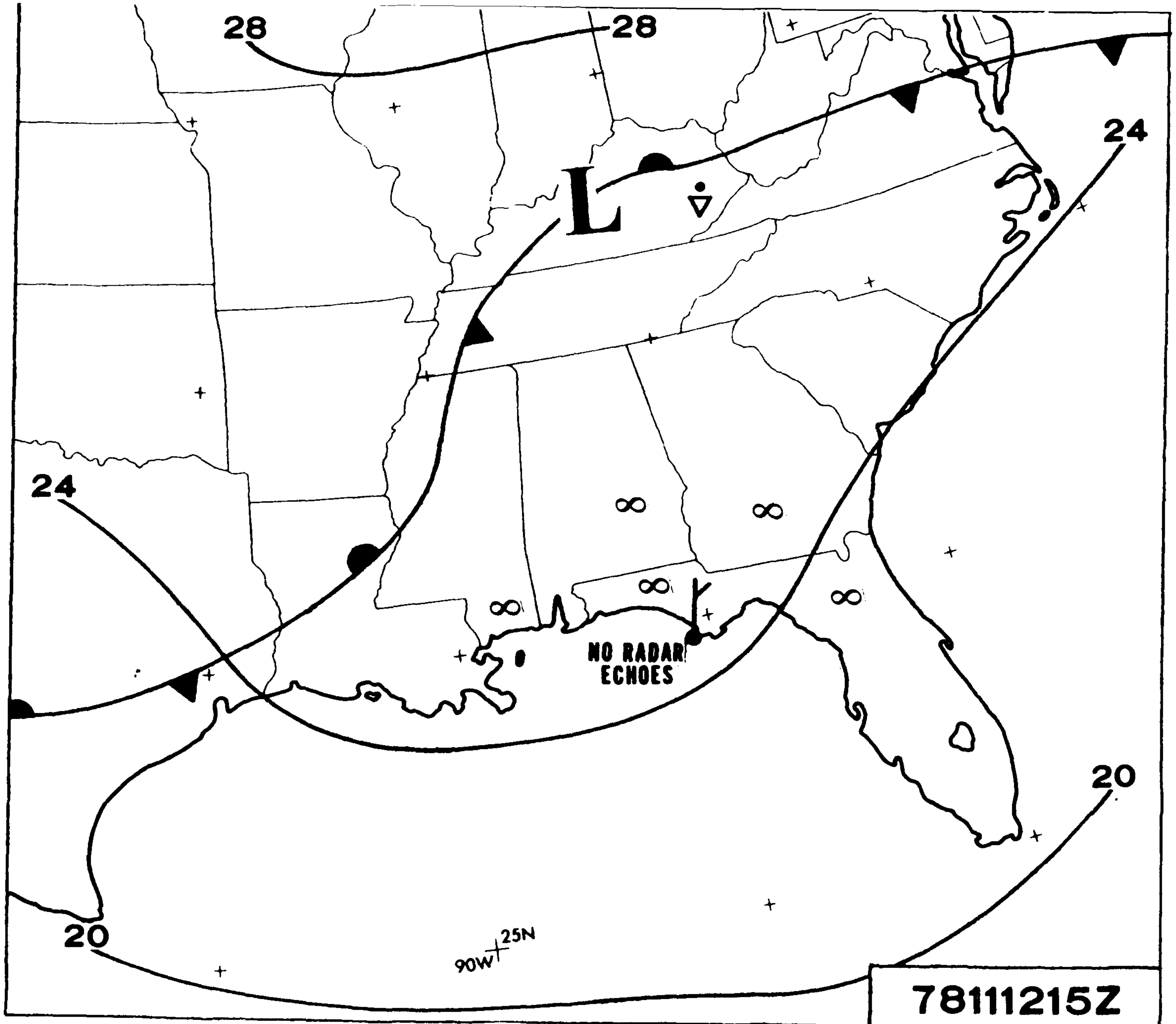


Figure 5-3 78111215Z Synoptic Chart

Table 5-1. Case 5, Apalachicola Surface Weather, 12 Nov 78, 0900Z - 12 Nov 78, 1500Z.

Date-Time (1978) (Z)	Temperature (^{o}C)	Dew-Point Depression (^{o}C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 12 06	12.2	1.1	CALM	CALM	CLR	6	F
09	10.6	0.0	200	3	CLR	6	F
12	10.0	0.0	200	3	CLR	4	F
15	18.3	4.4	60	6	SCT	7	None
18	23.9	12.8	50	9	CLR	7	None

Table 5-2. Case 5, Tyndall Surface Weather, 12 Nov 78, 0900Z - 12 Nov 78, 1500Z.

Date-Time (1978) (Z)	Temperature (^{o}C)	Dew-Point Depression (^{o}C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 12 06	14.4	4.4	CALM	CALM	CLR	7	None
09	12.2	4.4	CALM	CALM	CLR	7	None
12	10.0	3.3	330	2	CLR	7	None
15	20.0	7.2	20	2	SCT	7	None
18	24.4	15.5	40	4	SCT	7	None

Table 5-3. Case 5, *Eglin* Surface *Weather*, 12 Nov 78, *0900Z* - 12 Nov 78, 1500Z.

Date-Time (1978) (Z)	Temperature (^{o}C)	Dew-Point Depression (^{o}C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 12 06	15.6	4.5	CALM	CALM	CLR	7	None
09	12.2	2.2	CALM	CALM	CLR	10	None
12	11.1	1.1	CALM	CALM	SCT	6	F
15	20.6	6.7	10	3	SCT	7	None
18	26.1	15.0	30	8	SCT	7	None

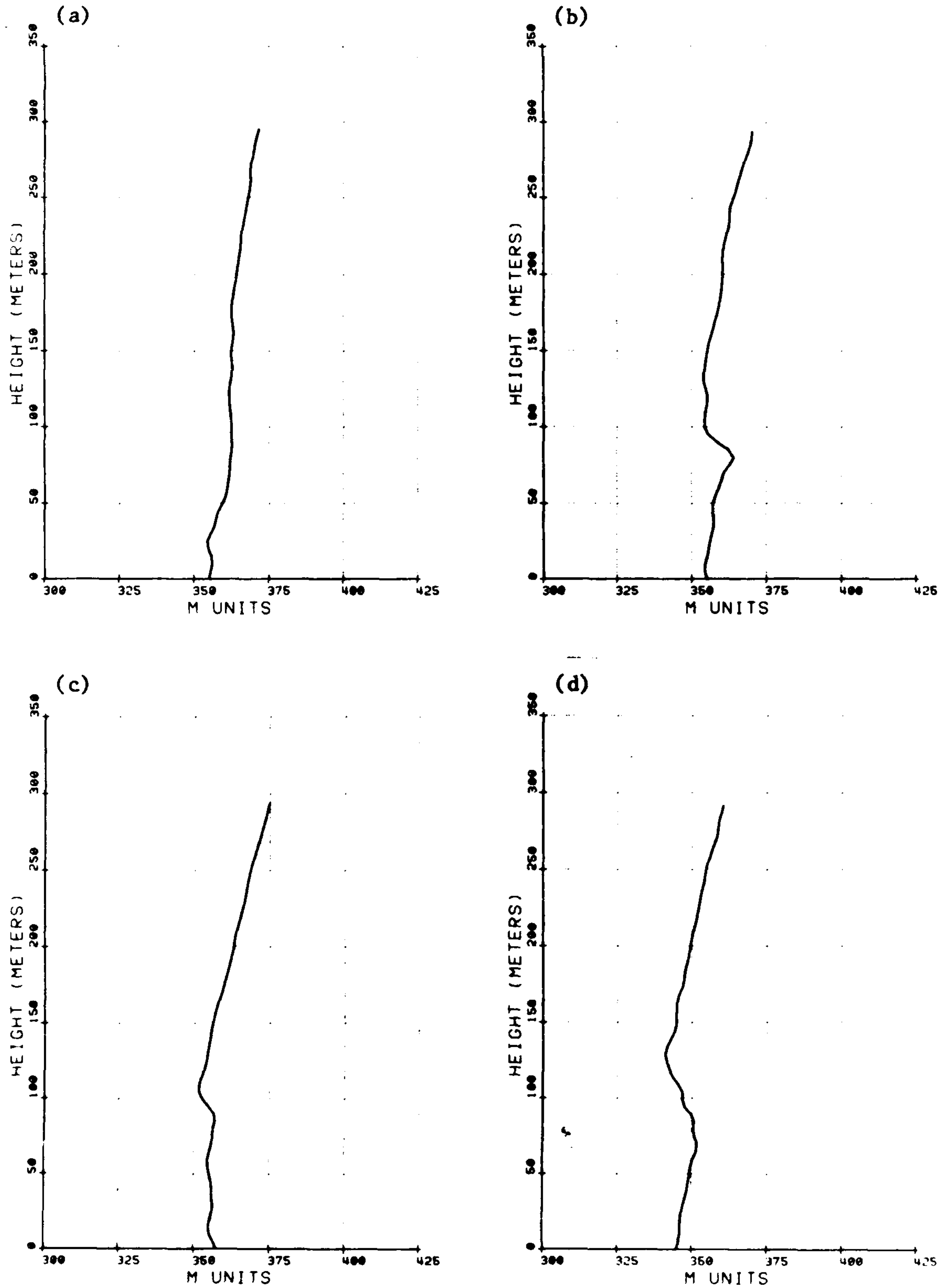


Figure 5-4 Case 5 M-Profiles: a. Cape San Blas, 12 Nov 78, 0800Z; b. Cape San Blas, 12 Nov 78, 1000Z; c. Cape San Blas, 12 Nov 78, 1200Z; d. Cape San Blas, 12 Nov 78, 1400Z.

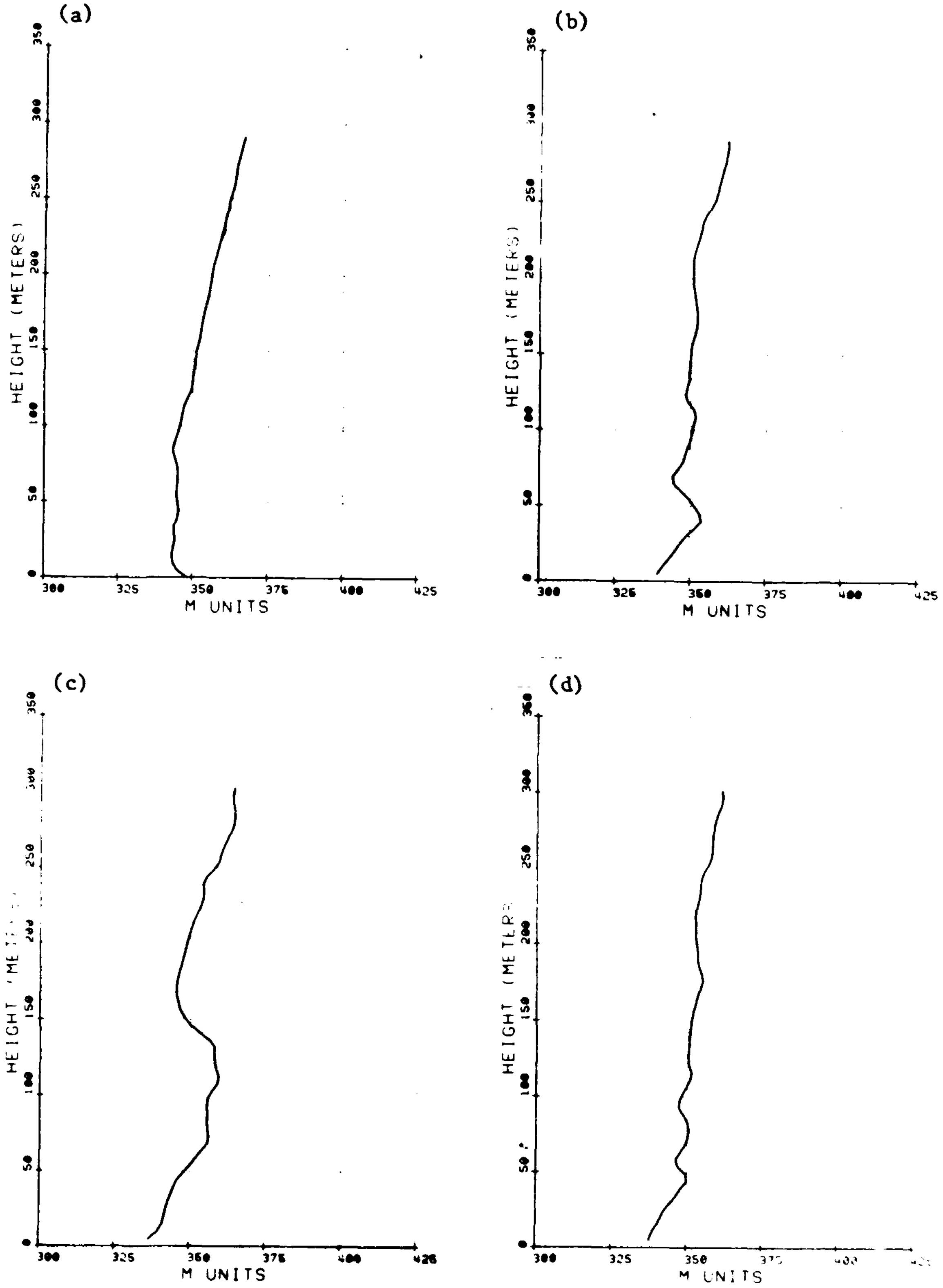


Figure 5-5 Case 5 M-Profiles: a. Cape San Blas, 12 Nov 78, 1600Z; b. Apalachicola, 12 Nov 78, 0800Z; c. Apalachicola, 12 Nov 78, 1000Z; d. Apalachicola, 12 Nov 78, 1200Z.

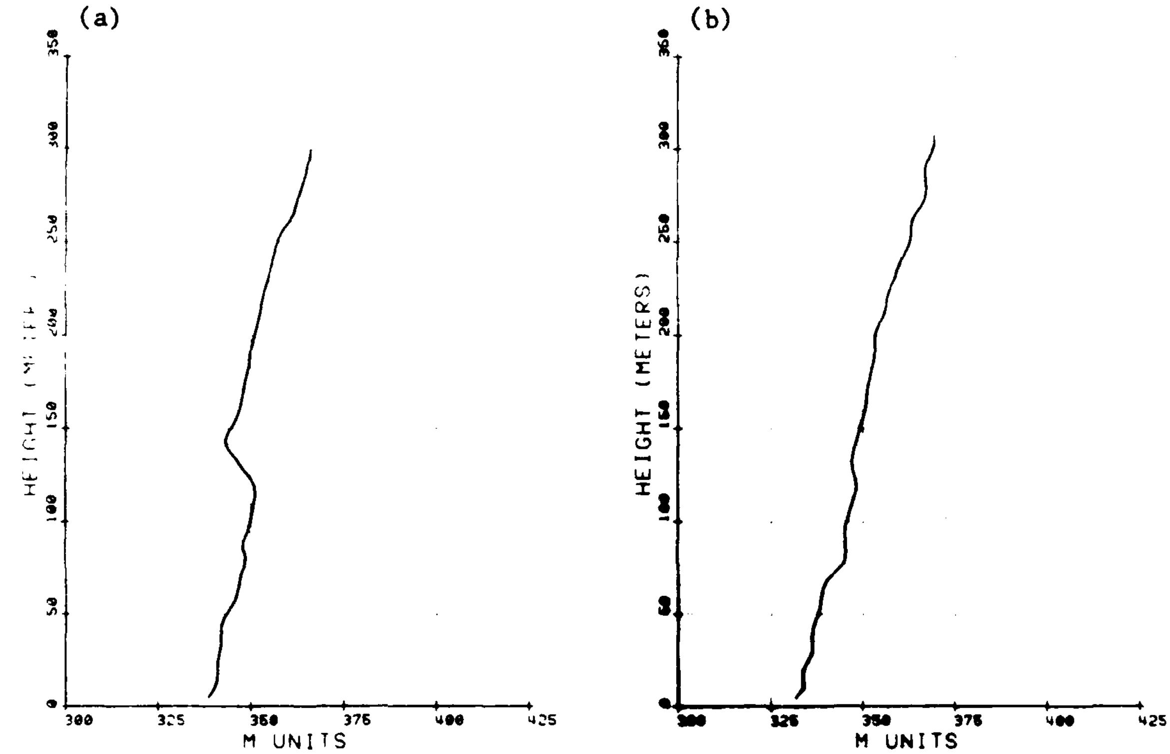


Figure 5-6 Case 5 M-Profiles: a. Apalachicola, 12 Nov 78, 1400Z; b. Apalachicola, 12 Nov 78, 1600Z.

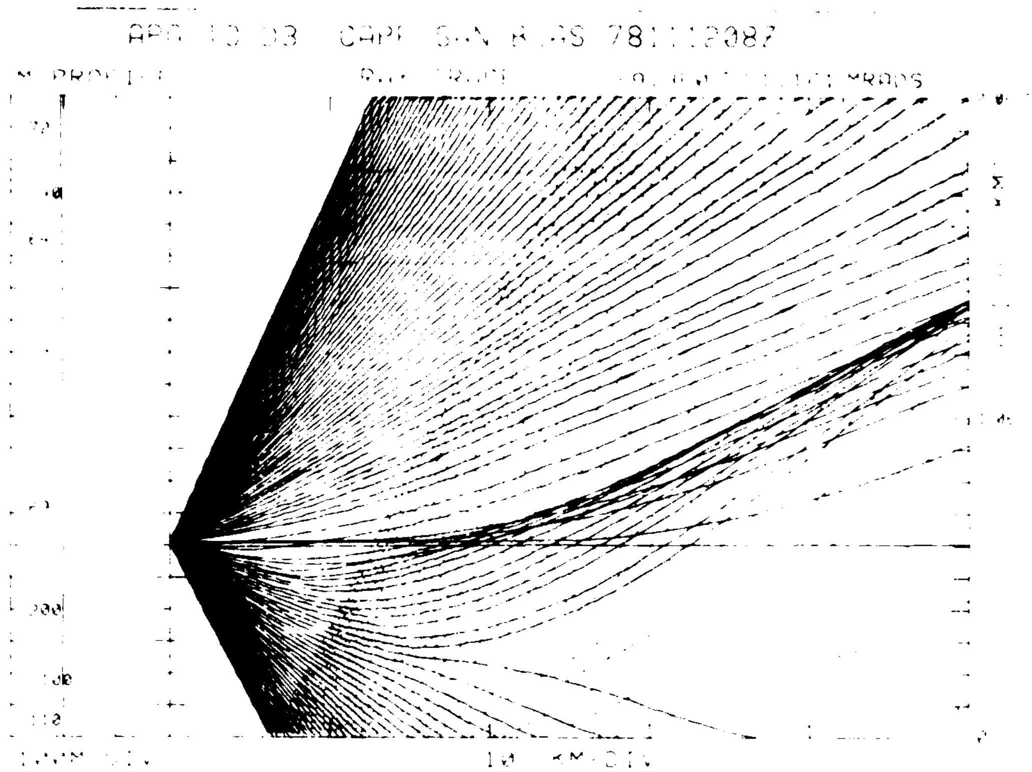


Figure 5-7. Case 5 Raytrace, APA to D3, Cape San Blas, 12 Nov 78, 0800Z, Transmitter Height 61.0 m.

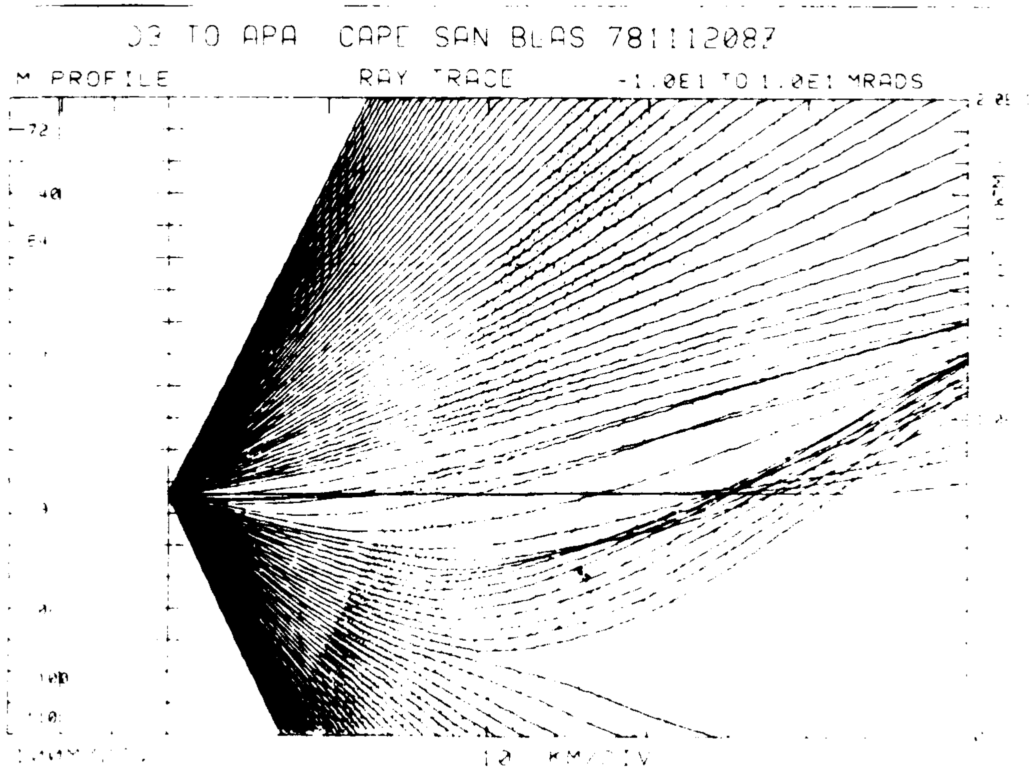


Figure 5-8. Case 5 Raytrace, D3 to APA, Cape San Blas, 12 Nov 78, 0800Z, Transmitter Height 76.2 m.

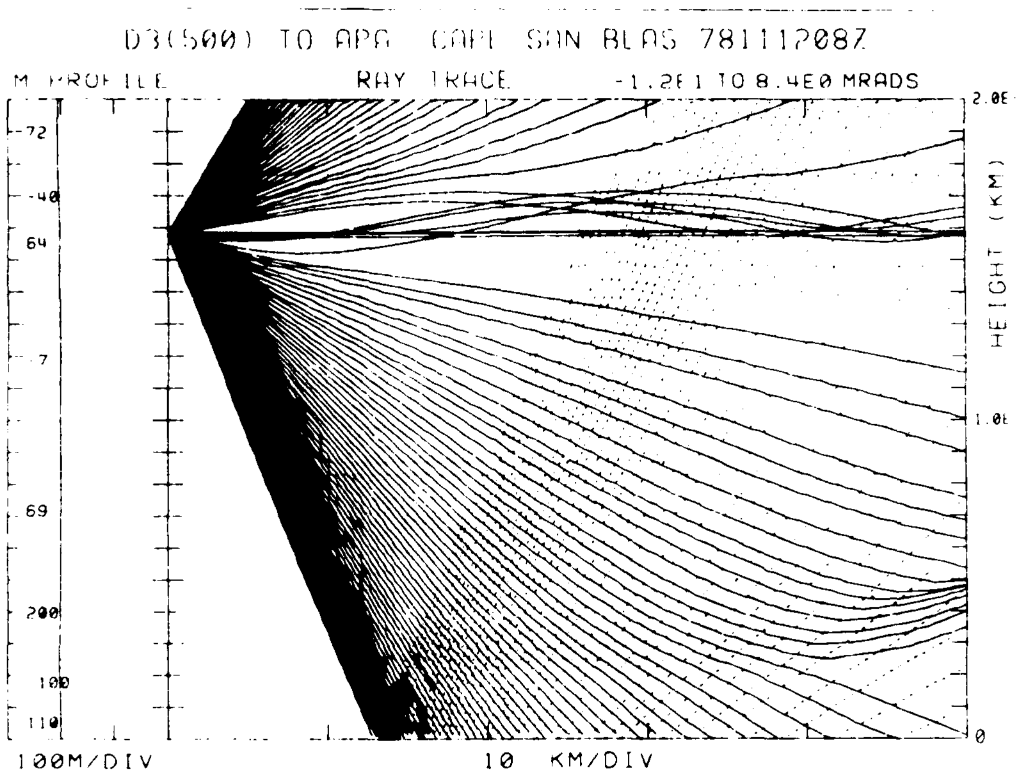


Figure 5-9. Case 5 Raytrace, D3(500) to APA, Cape San Blas 12 Nov 78, 0800Z, Transmitter Height 158.4 m.

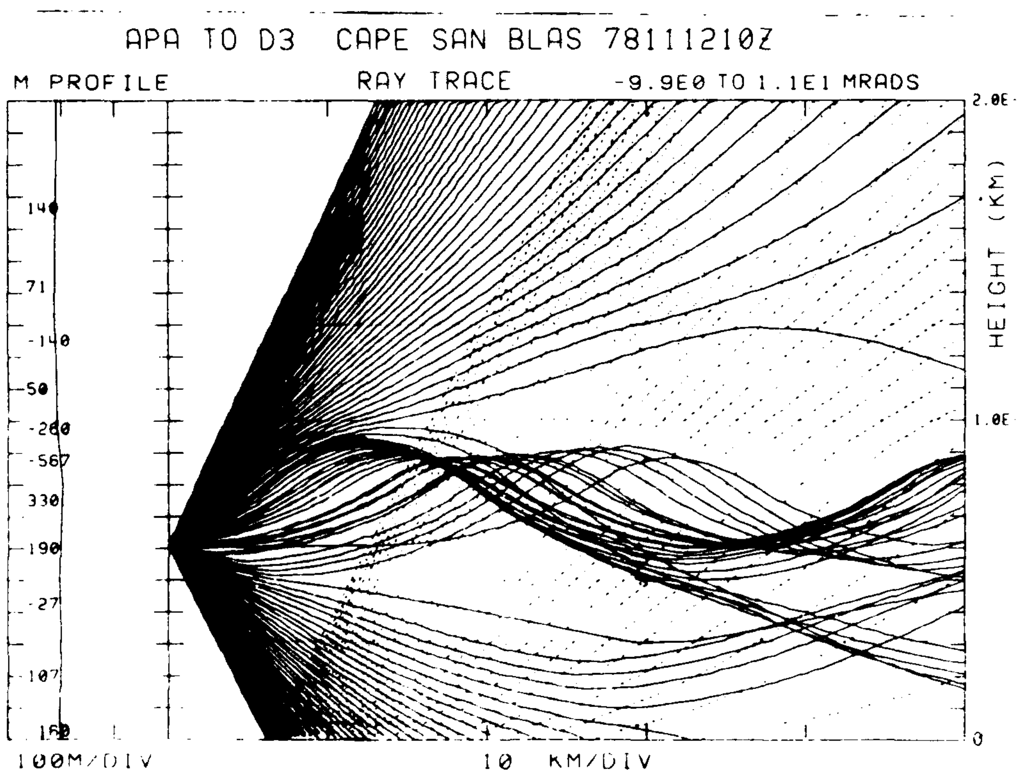


Figure 5-10. Case 5 Raytrace, APA to D3, Cape San Blas, 12 Nov 78, 1000Z, Transmitter Height 61.0 m.

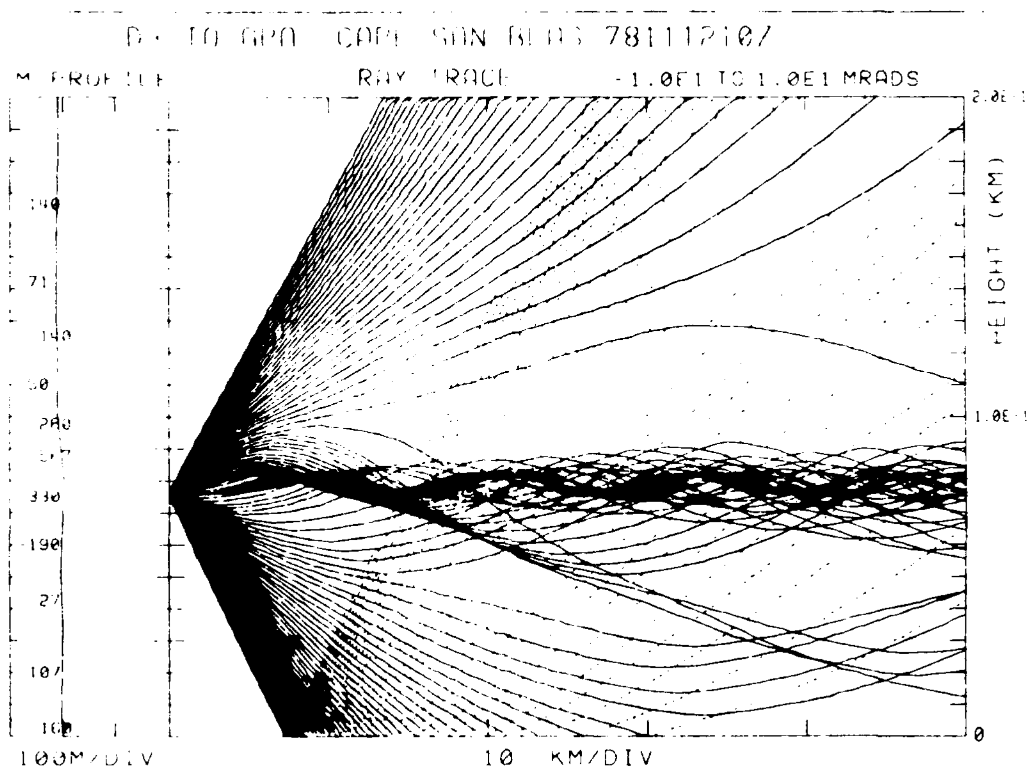


Figure 5-11. Case 5 Raytrace, D3 to APA, Cape San Blas, 12 Nov 78, 1000Z, Transmitter Height 76.2 m.

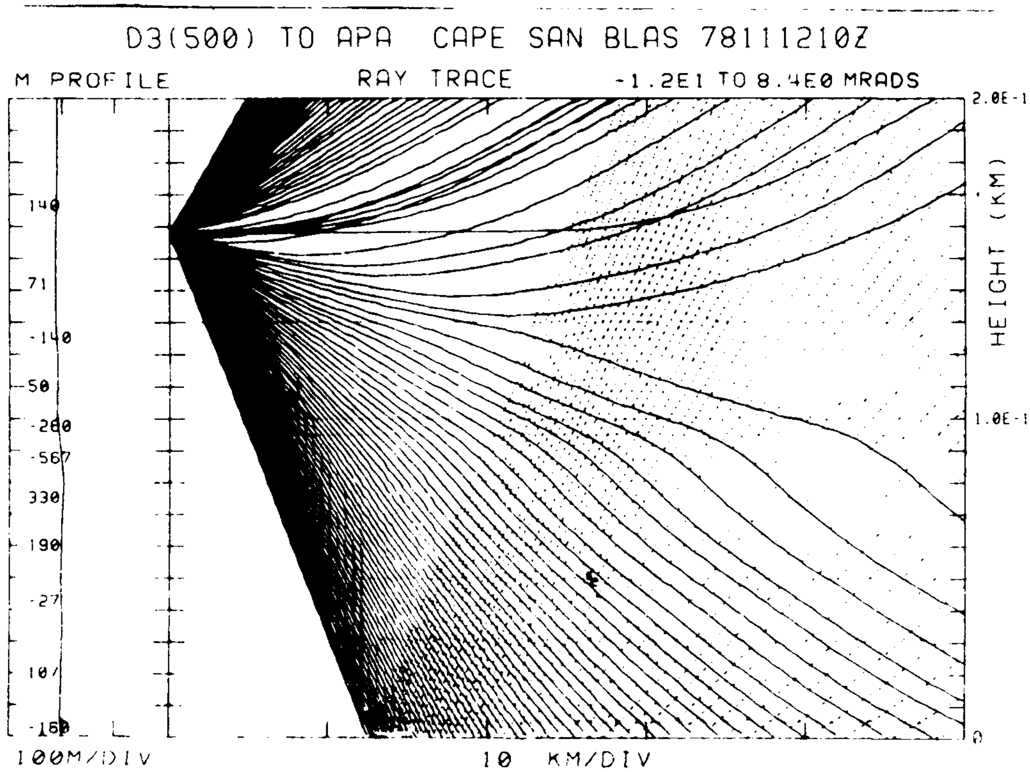


Figure 5-12. Case 5 Raytrace, D3(500) to APA, Cape San Blas 12 Nov 78, 1000Z, Transmitter Height 158.4 m.

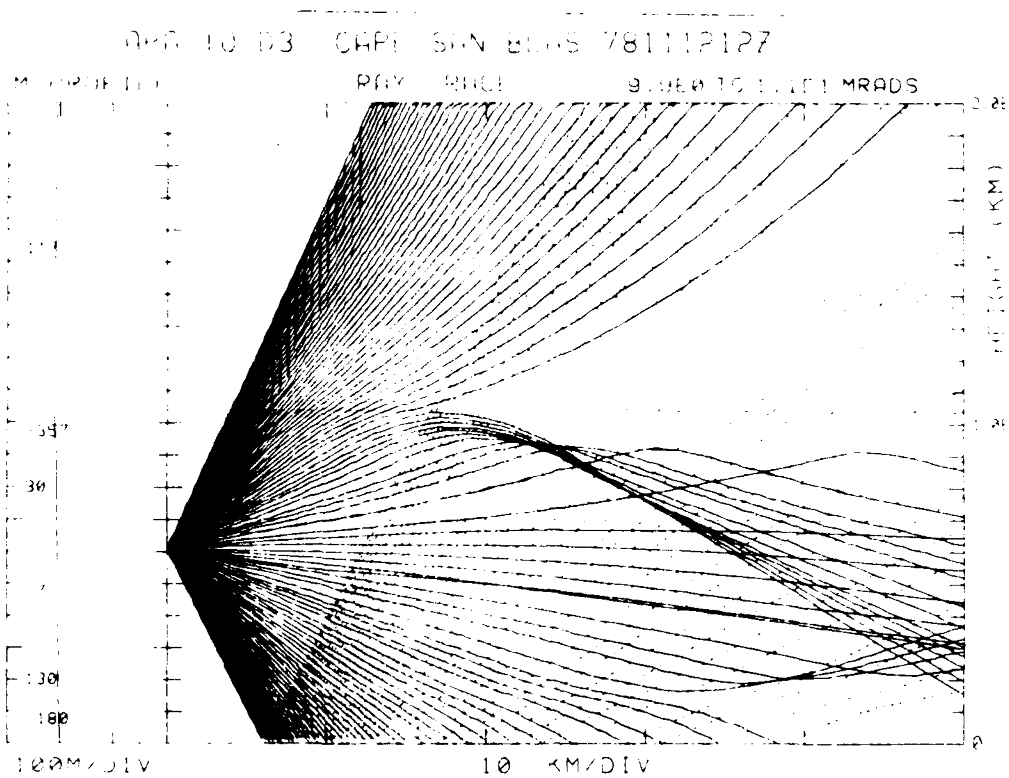


Figure 5-13. Case 5 Raytrace, APA to D3, Cape San Blas, 12 Nov 78, 1200Z, Transmitter Height 61.0 m.

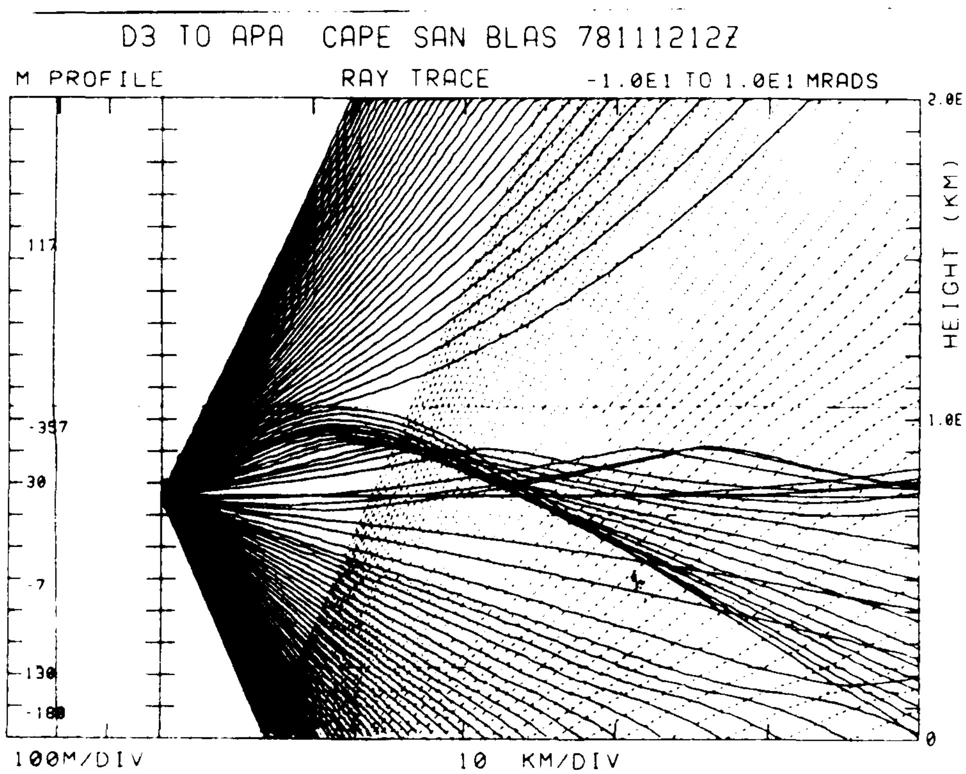


Figure 5-14. Case 5 Raytrace, D3 to APA, Cape San Blas, 12 Nov 78, 1200Z, Transmitter Height 76.2 m.

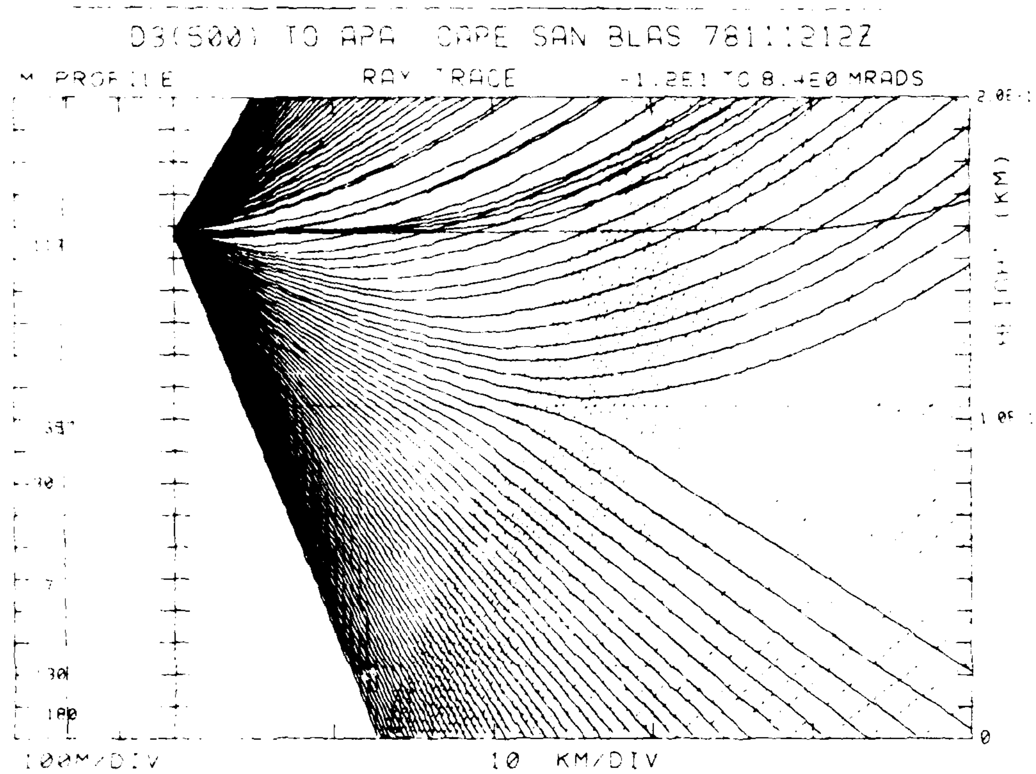


Figure 5-15. Case 5 Raytrace, D3(500) to APA, Cape San Blas 12 Nov 78, 1200Z, Transmitter Height 158.4 m.

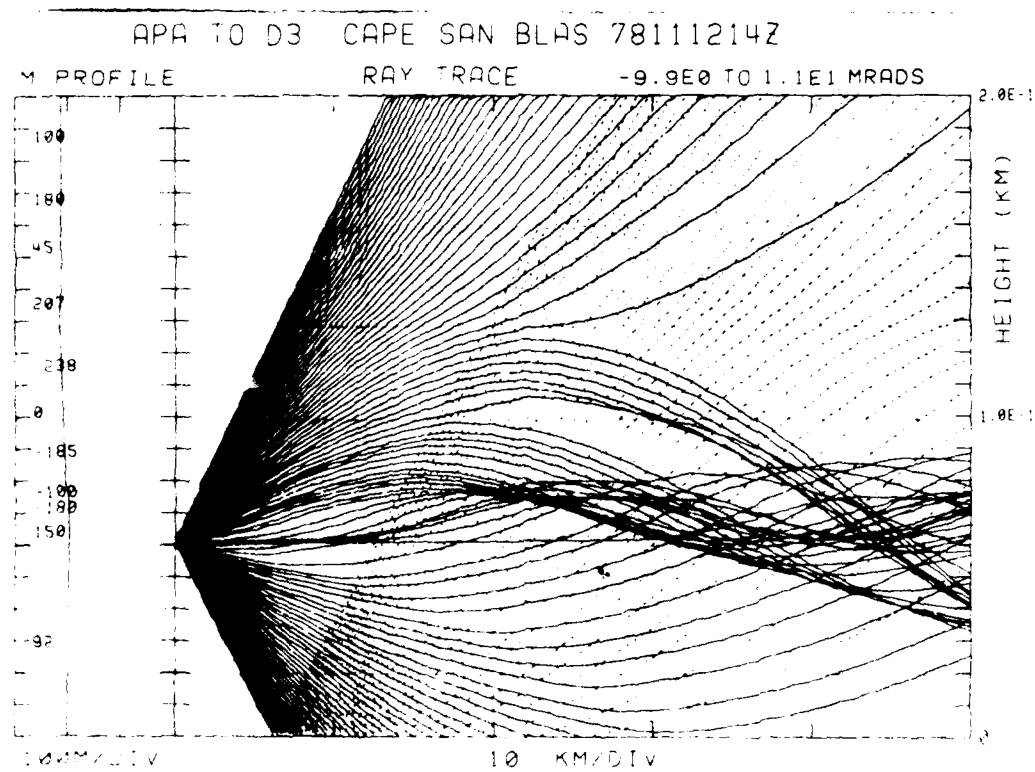


Figure 5-16. Case 5 Raytrace, APA to D3, Cape San Blas, 12 Nov 78, 1400Z, Transmitter Height 61.0 m.

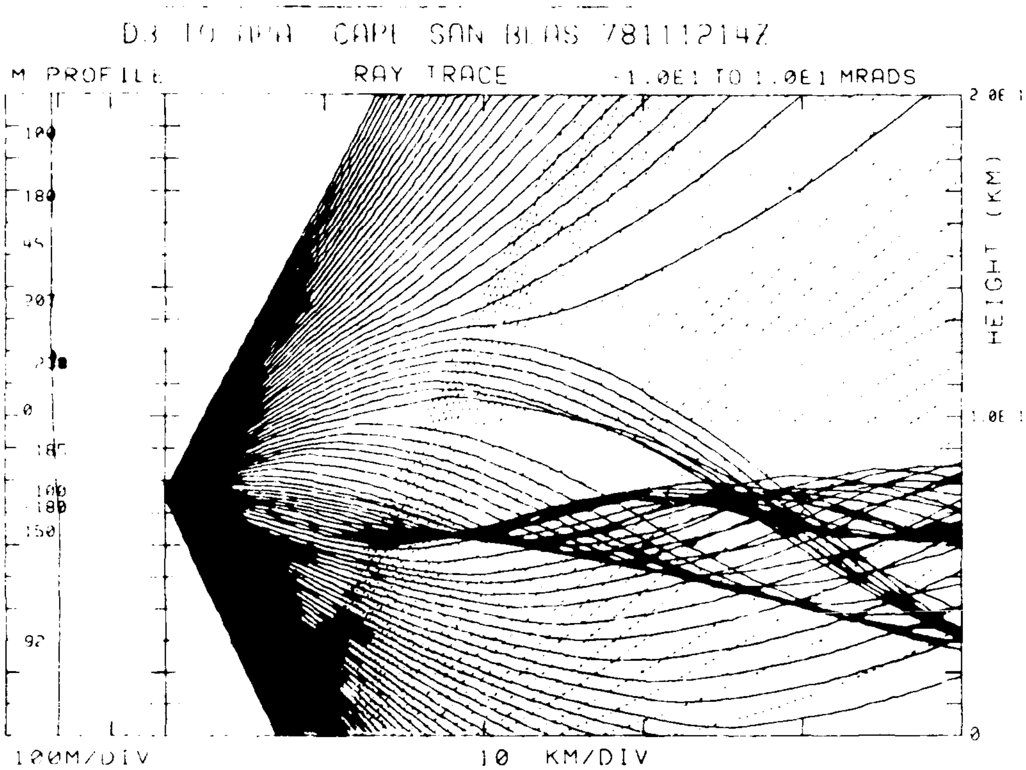


Figure 5-17. **Case 5 Raytrace, D3 to APA, Cape San Blas, 12 Nov 78, 1400Z, Transmitter Height 76.2 m.**

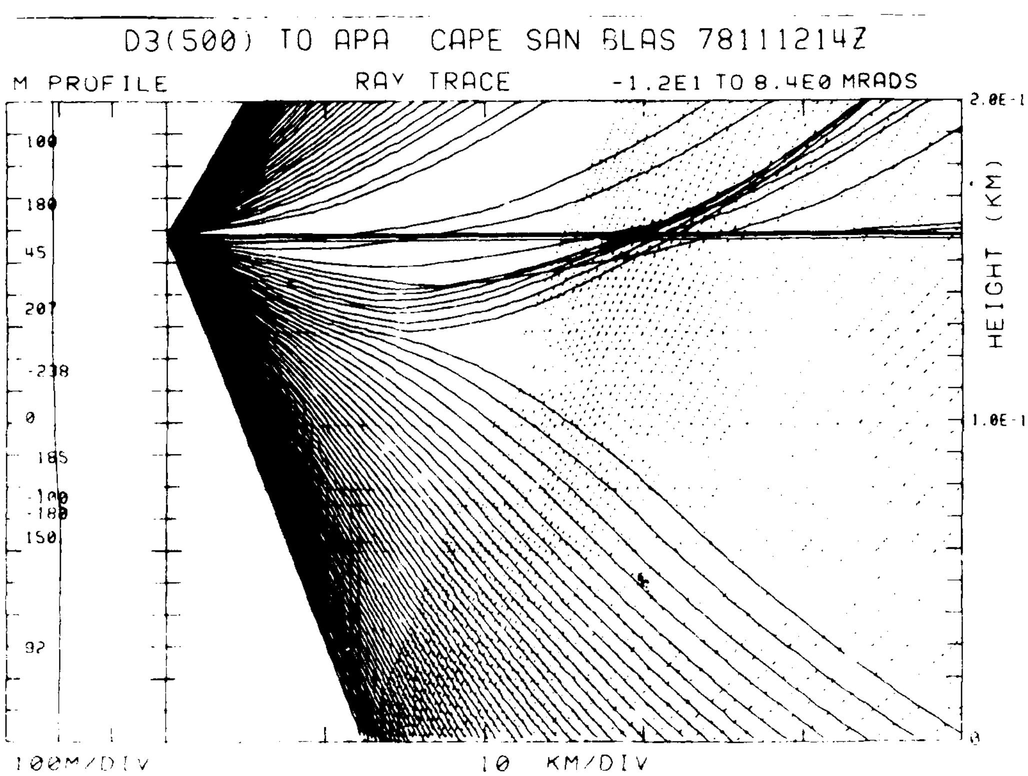


Figure 5-18. **Case 5 Raytrace, D3(500) to APA, Cape San Blas 12 Nov 78, 1400Z, Transmitter Height 158.4 m.**

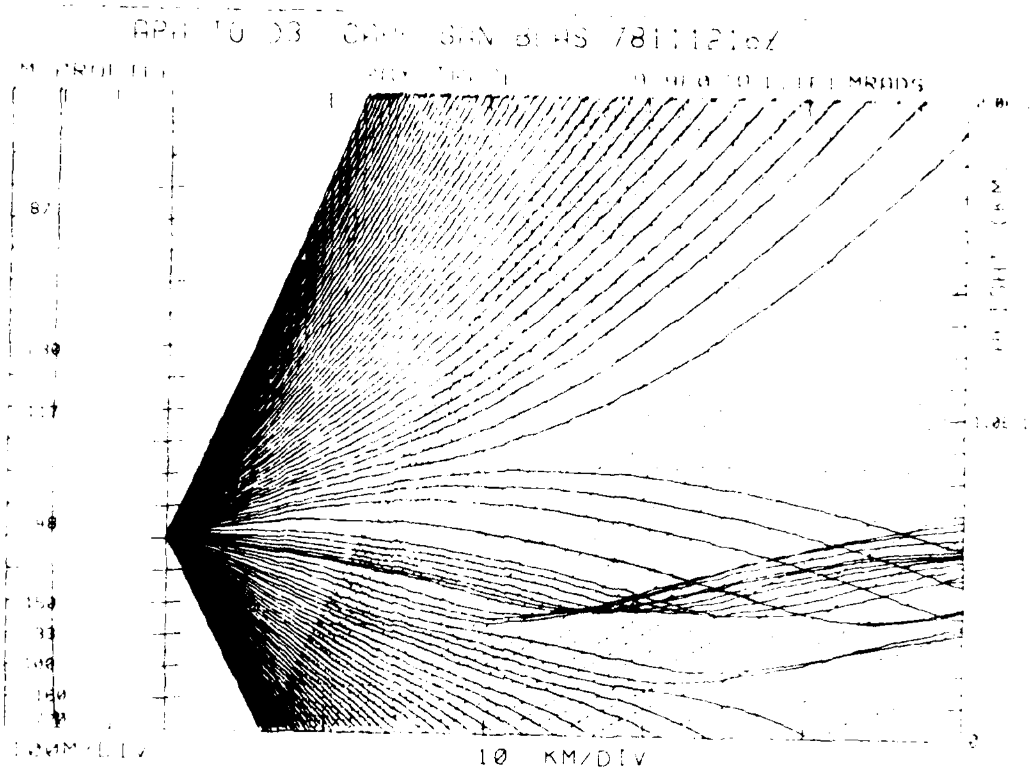


Figure 5-19. Case 5 Raytrace, APA to D3, Cape San Blas, 12 Nov 78, 1600Z, Transmitter Height 61.0 m.

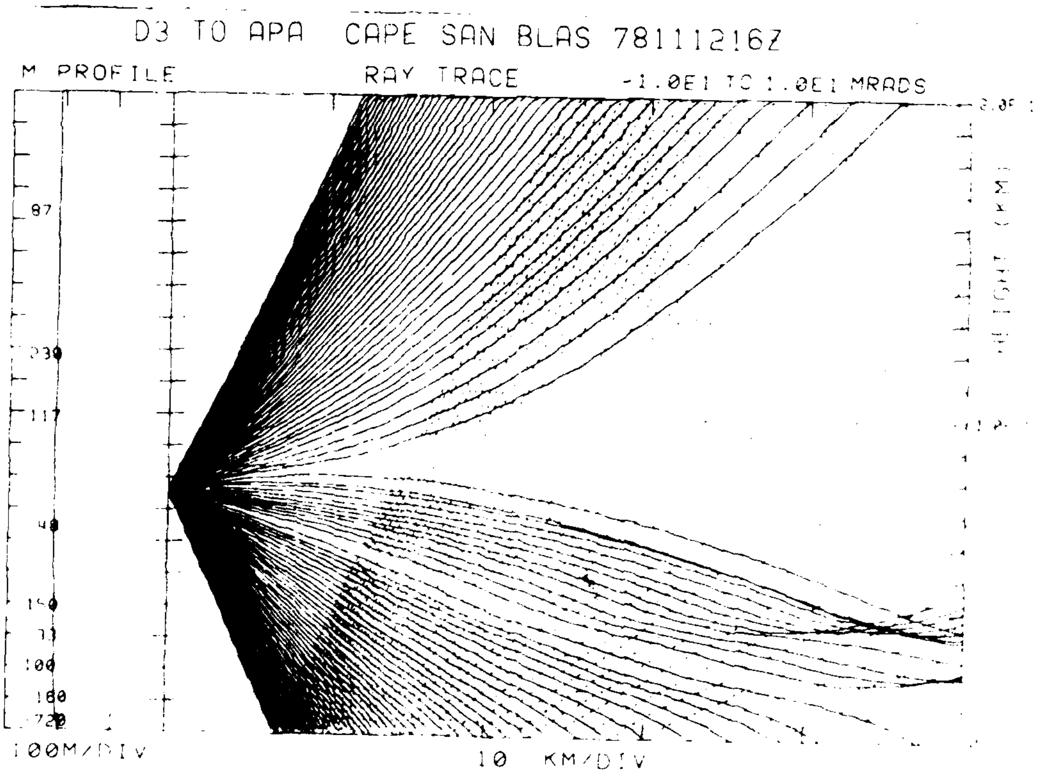


Figure 5-20. Case 5 Raytrace, D3 to APA, Cape San Blas, 12 Nov 78, 1600Z, Transmitter Height 76.2 m.

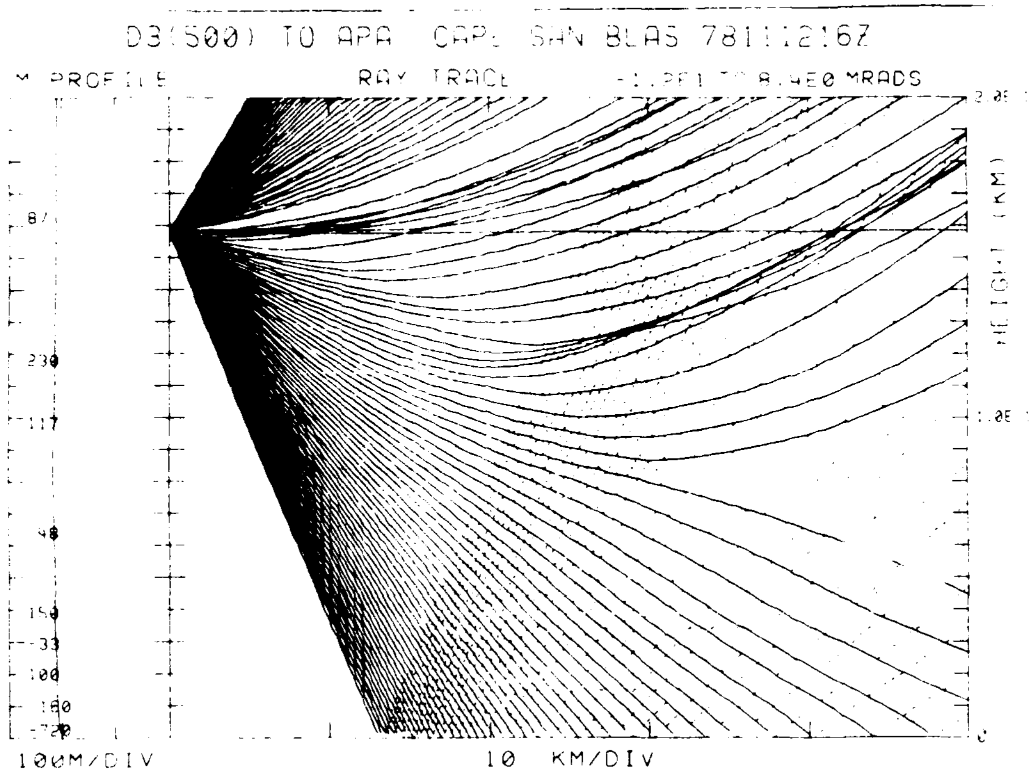


Figure 5-21. Case 5 Raytrace, D3(500) to APA, Cape San Blas 12 Nov 78, 1600Z, Transmitter Height 158.4 m.

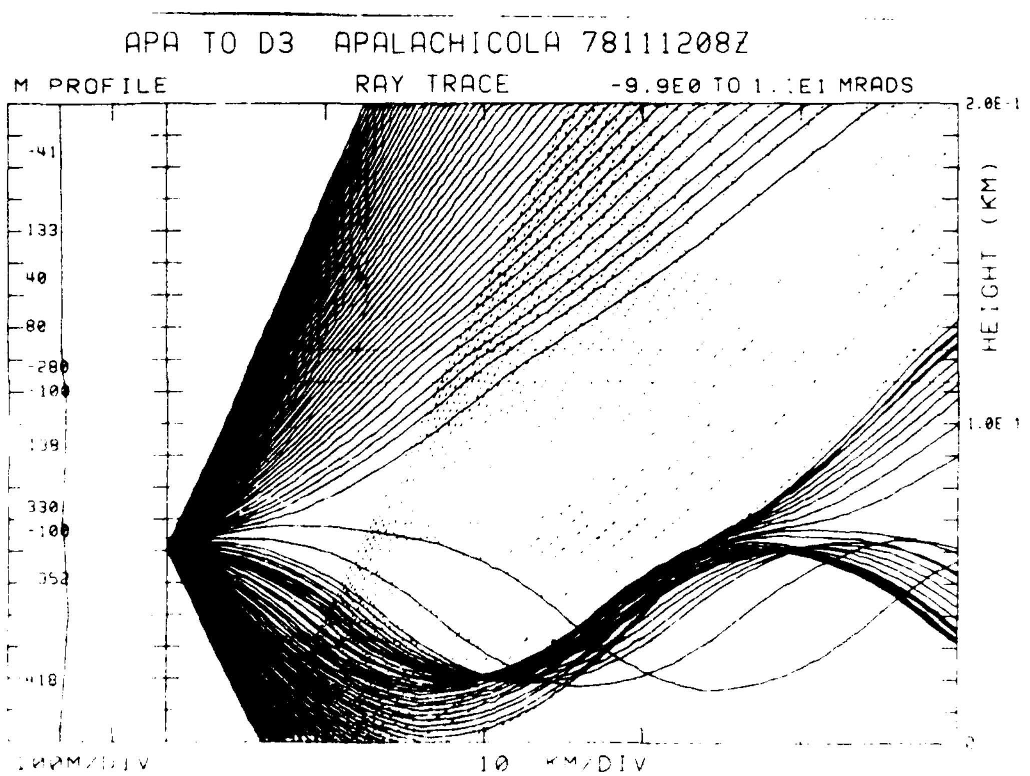


Figure 5-22. Case 5 Raytrace, APA to D3, Apalachicola, 12 Nov 78, 0800Z, Transmitter Height 61.0 m.

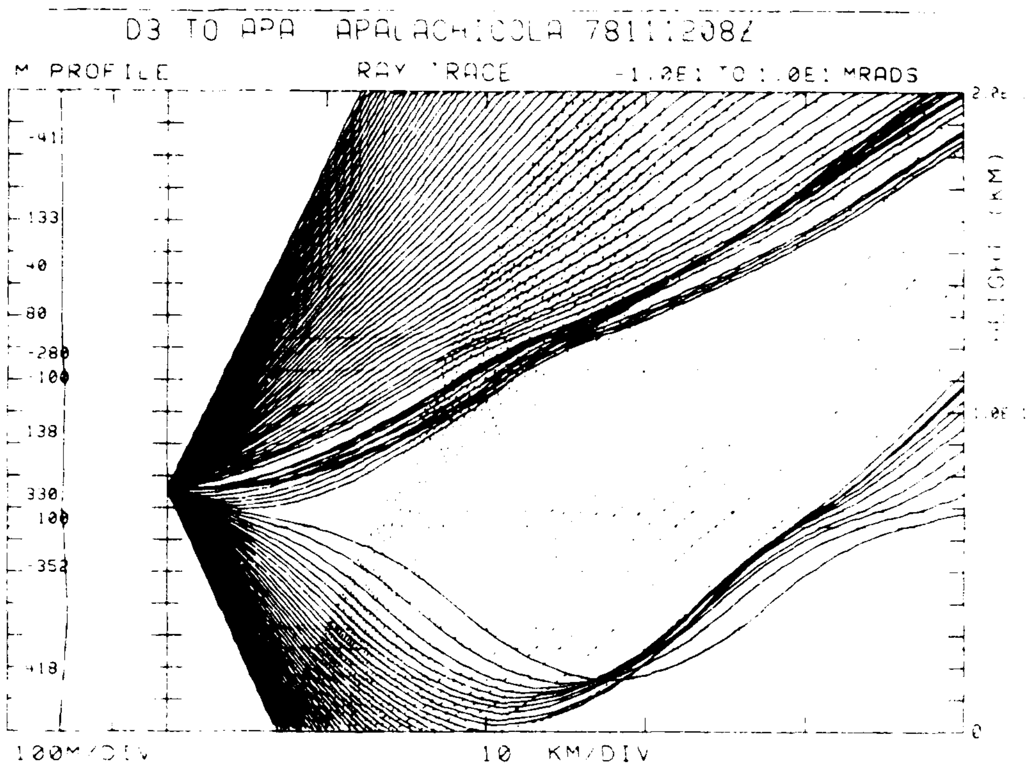


Figure 5-23. Case 5 Raytrace, D3 to APA, Apalachicola, 12 Nov 78, 0800Z, Transmitter Height 76.2 m.

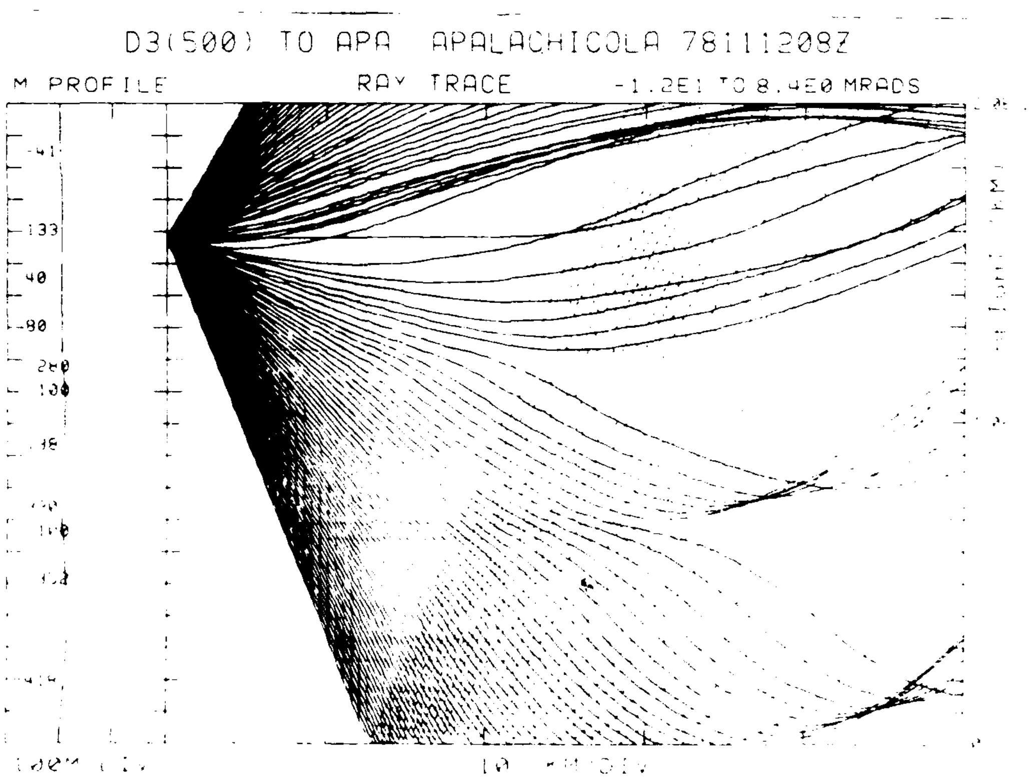


Figure 5-24. Case 5 Raytrace, D3(500) to APA, Apalachicola 12 Nov 78, 0800Z, Transmitter Height 158.4 m.

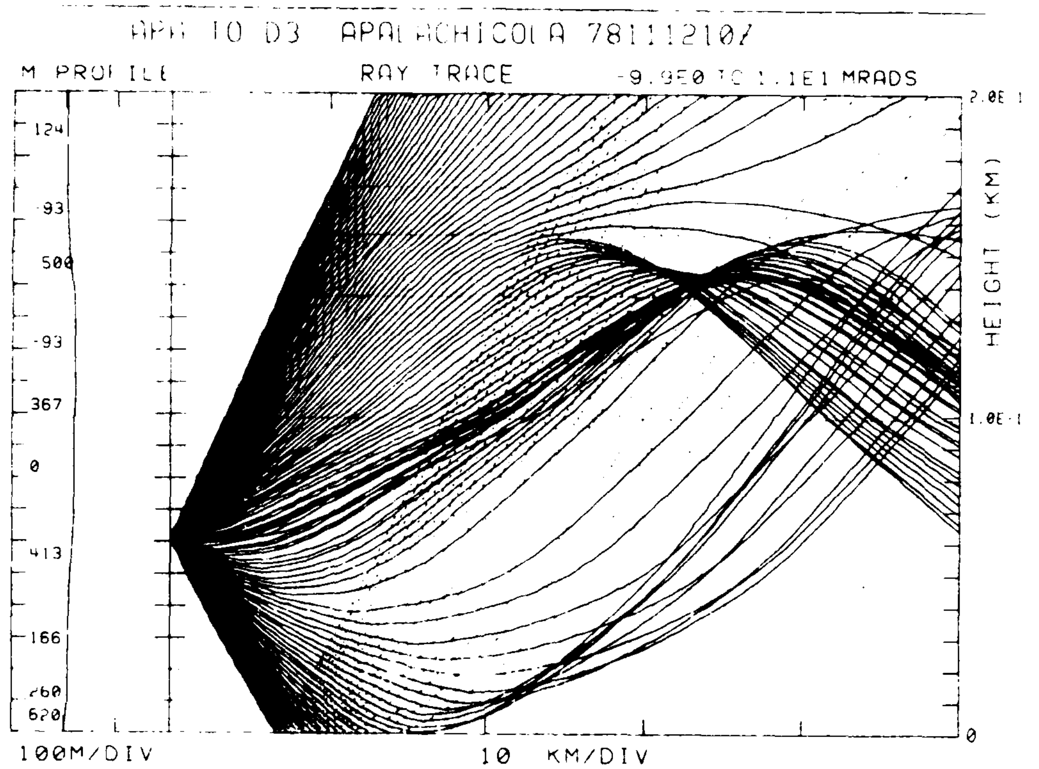


Figure 5-25. Case 5 Raytrace, APA to D3, Apalachicola, 12 Nov 78, 1000Z, Transmitter Height 61.0 m.

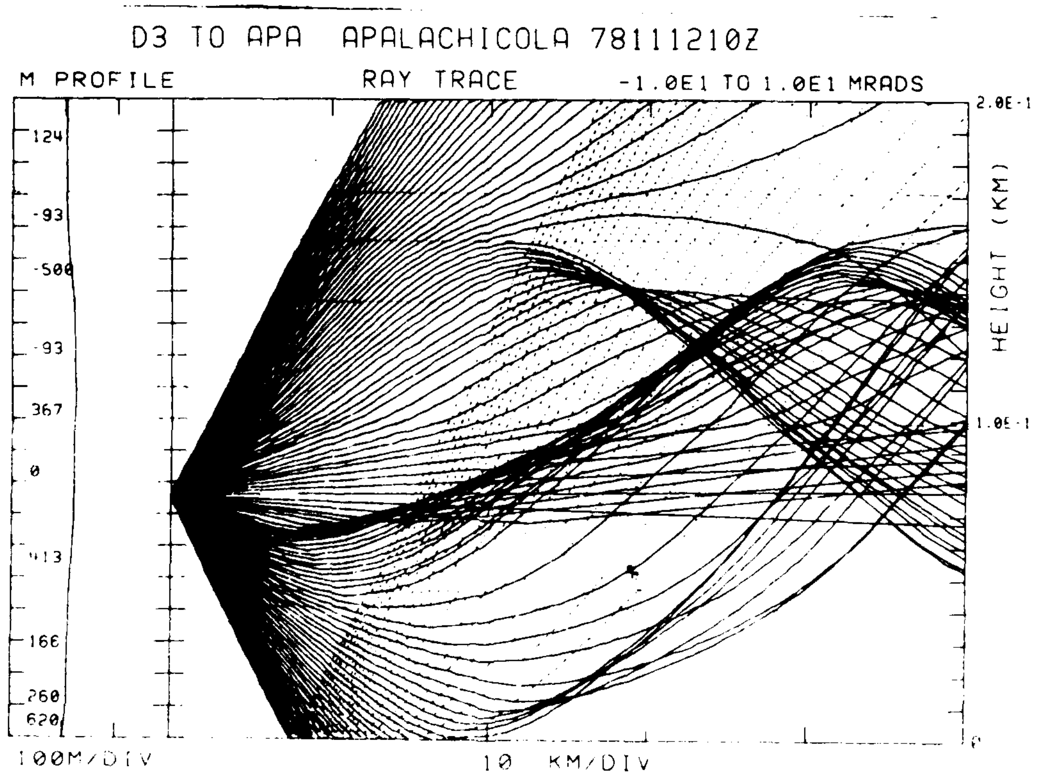


Figure 5-26. Case 5 Raytrace, D3 to APA, Apalachicola, 12 Nov 78, 1000Z, Transmitter Height 76.2 m.

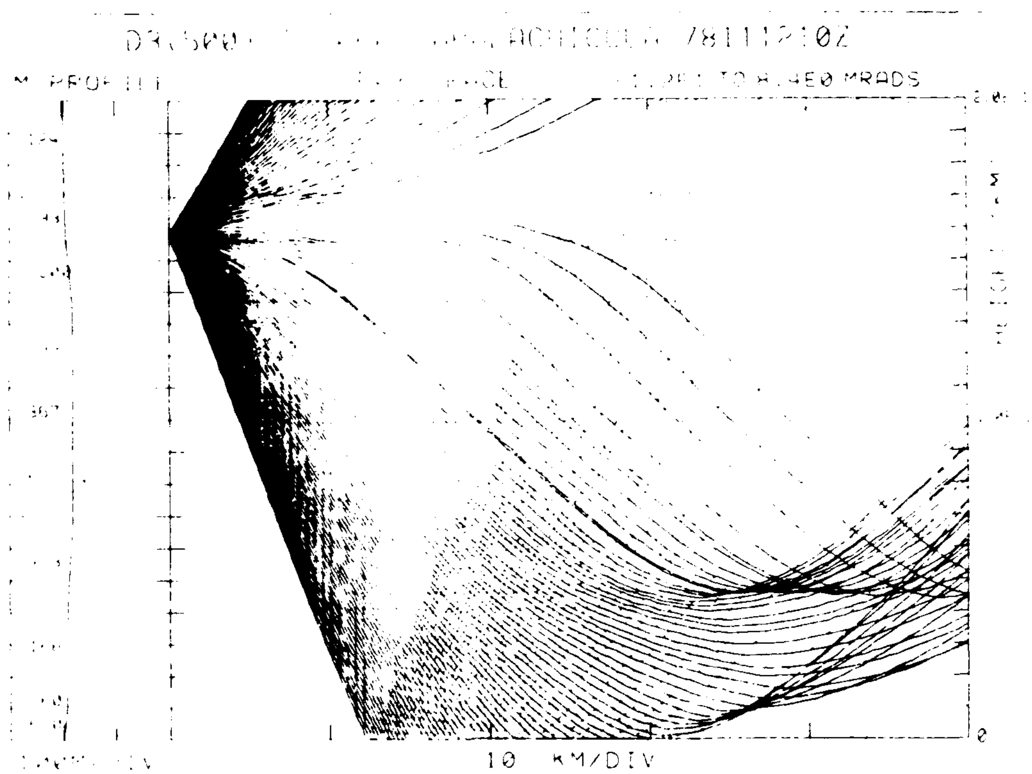


Figure 5-27. Case 5 Raytrace, D3(500) to APA, Apalachicola 12 Nov 78, 1000Z, Transmitter Height 158.4 m.

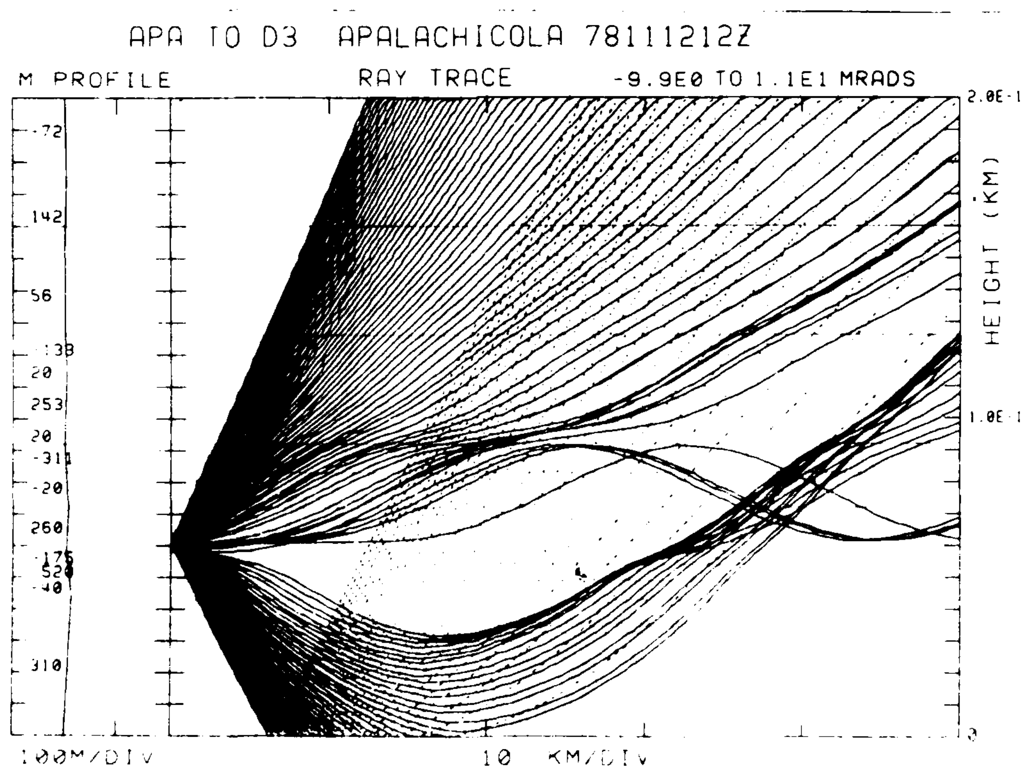


Figure 5-28. Case 5 Raytrace, APA to D3, Apalachicola, 12 Nov 78, 1200Z, Transmitter Height 61.0 m.

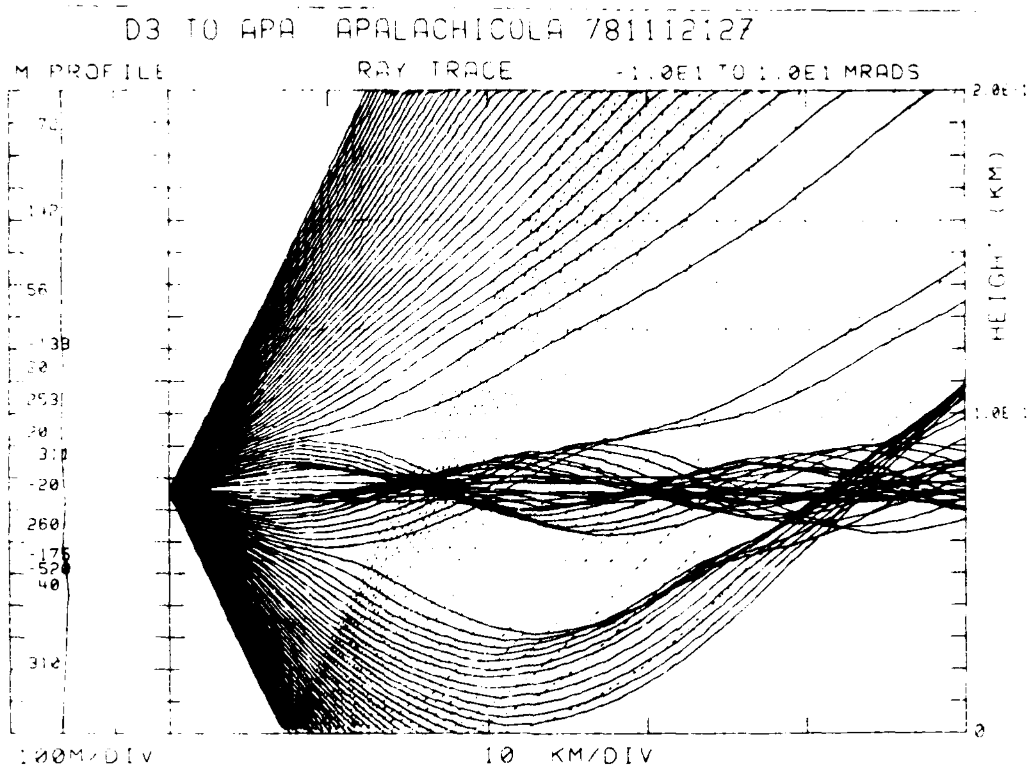


Figure 5-29. Case 5 Raytrace, D3 to APA, Apalachicola, 12 Nov 78, 1200Z, Transmitter Height 76.2 m.

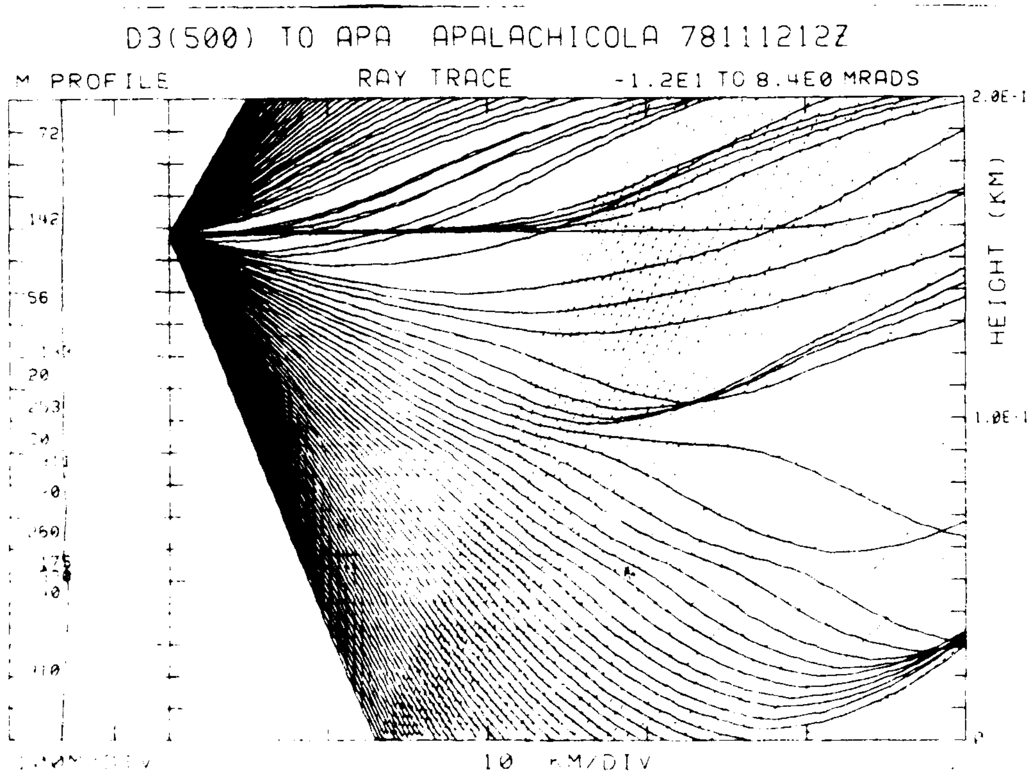


Figure 5-30. Case 5 Raytrace, D3(500) to APA, Apalachicola 12 Nov 78, 1200Z, Transmitter Height 158.4 m.

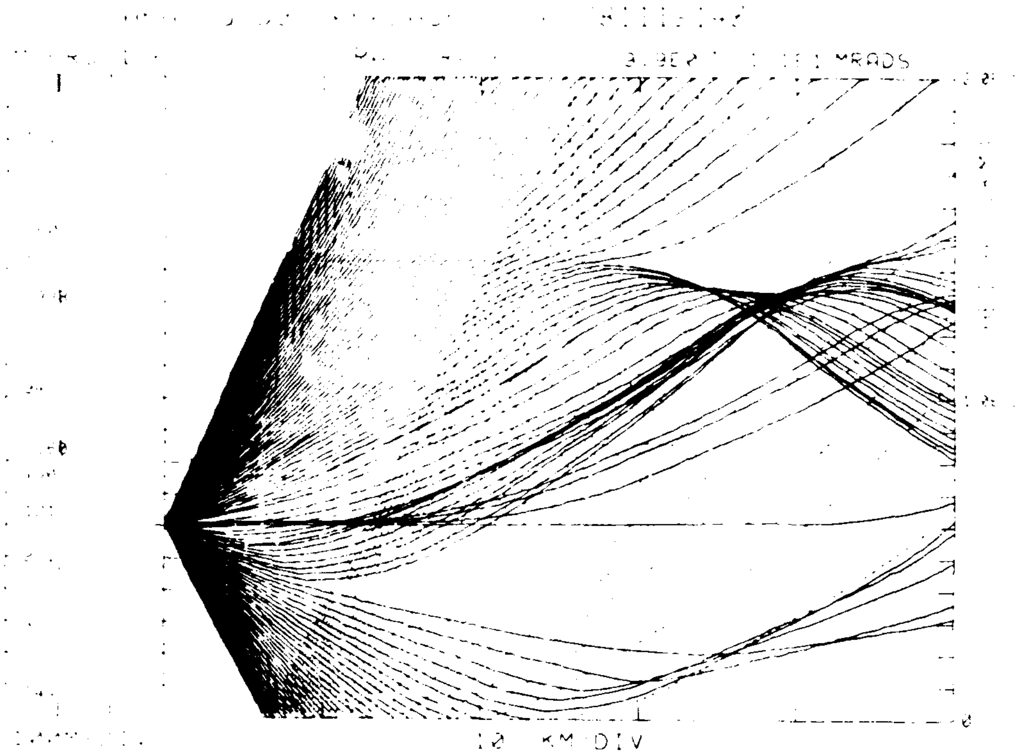


Figure 5-31 . Case 5 Raytrace, APA to D3, Apalachicola, 12 Nov 78, 1400Z, Transmitter Height 61.0 m.

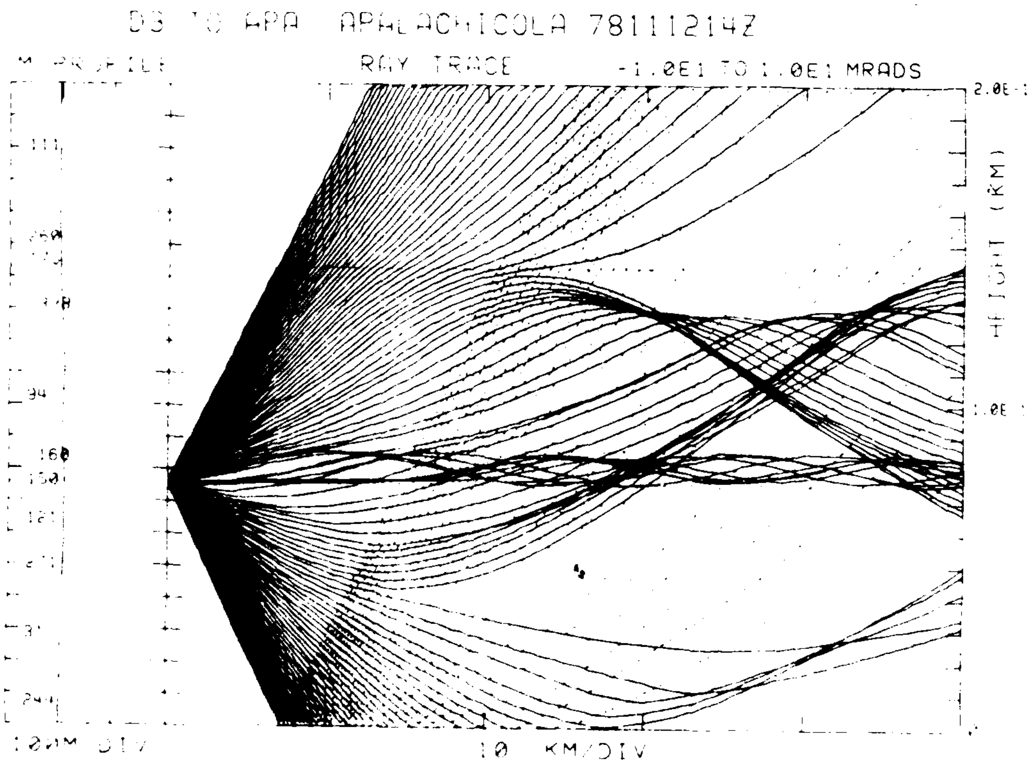


Figure 5-32 . Case 5 Raytrace, D3 to APA, Apalachicola, 12 Nov 78, 1400Z, Transmitter Height 76.2 m.

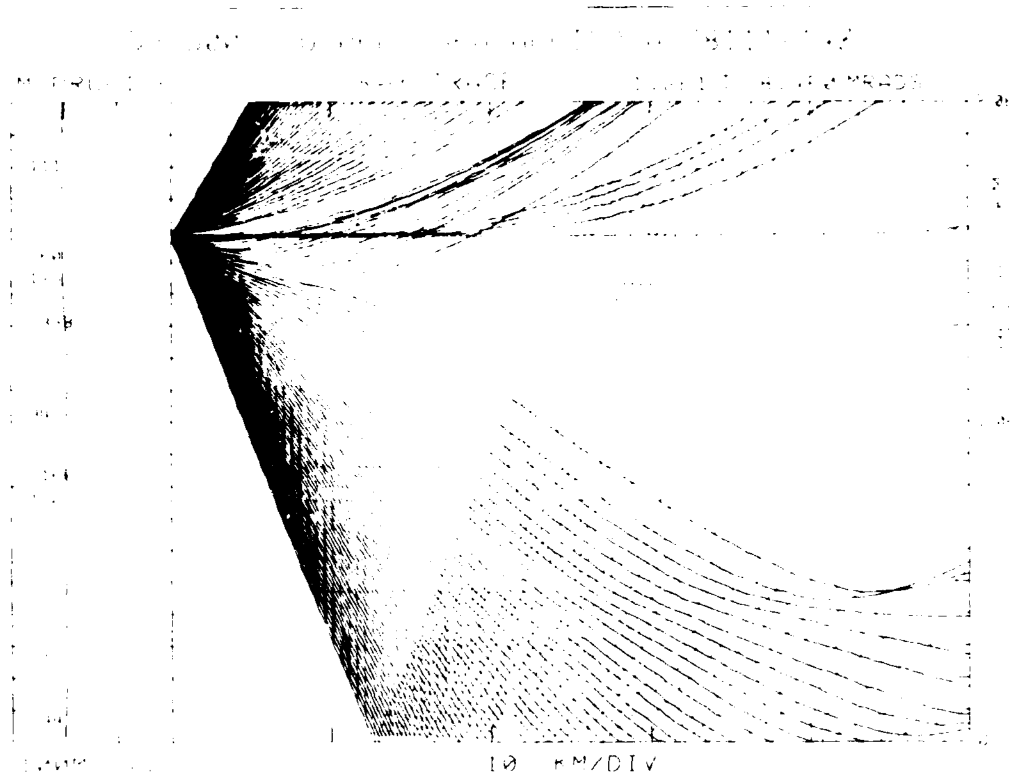


Figure 5-33 . Case 5 Raytrace, D3(500) to APA, Apalachicola 12 Nov 78, 1400Z, Transmitter Height 158.4 m.

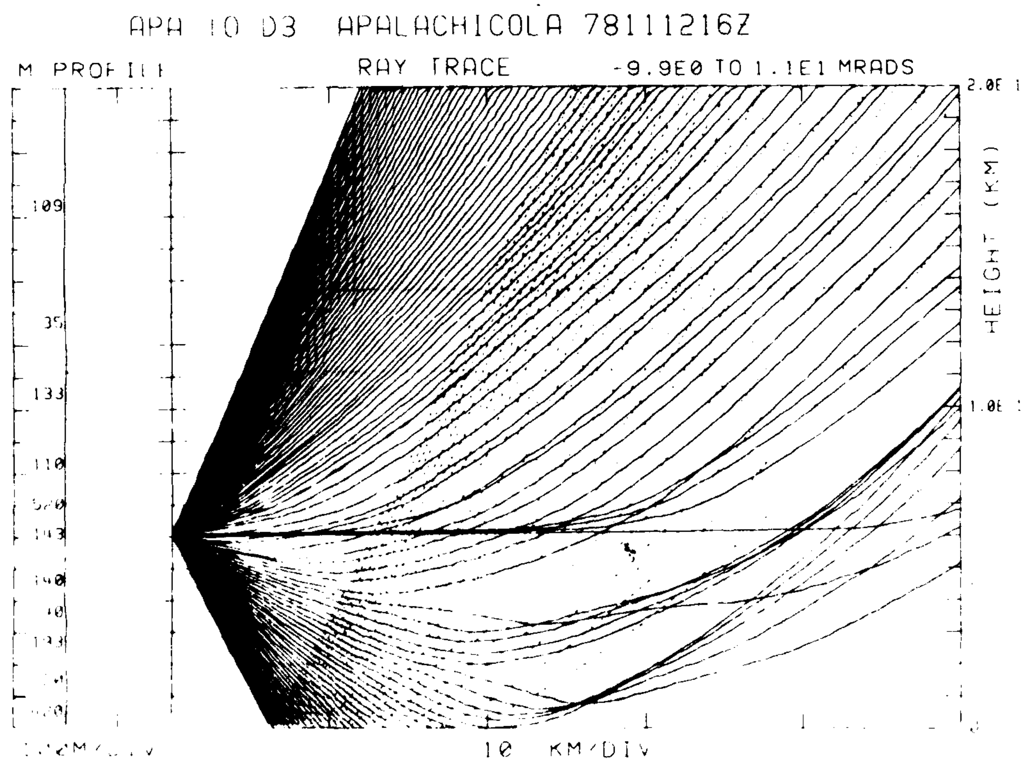


Figure 5-34. Case 5 Raytrace, APA to D3, Apalachicola, 12 Nov 78, 1600Z, Transmitter Height 61.0 m.

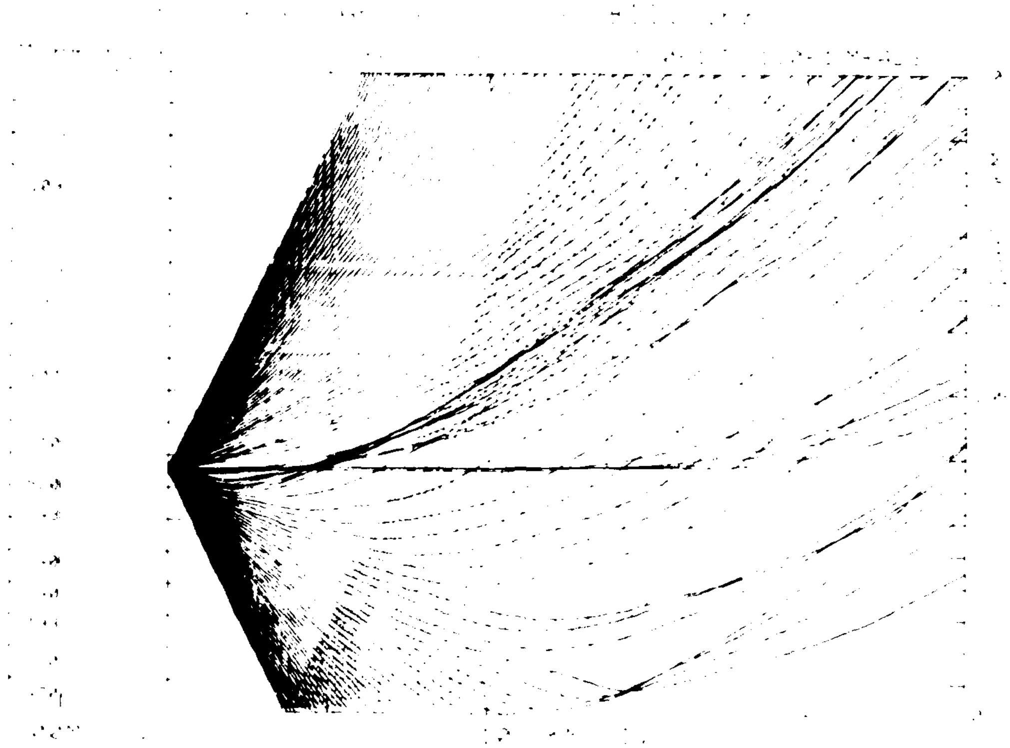


Figure 5-35. Case 5 Raytrace, D3 to APA, Apalachicola, 12 Nov 78, 1600Z, Transmitter Height 76.2 m.

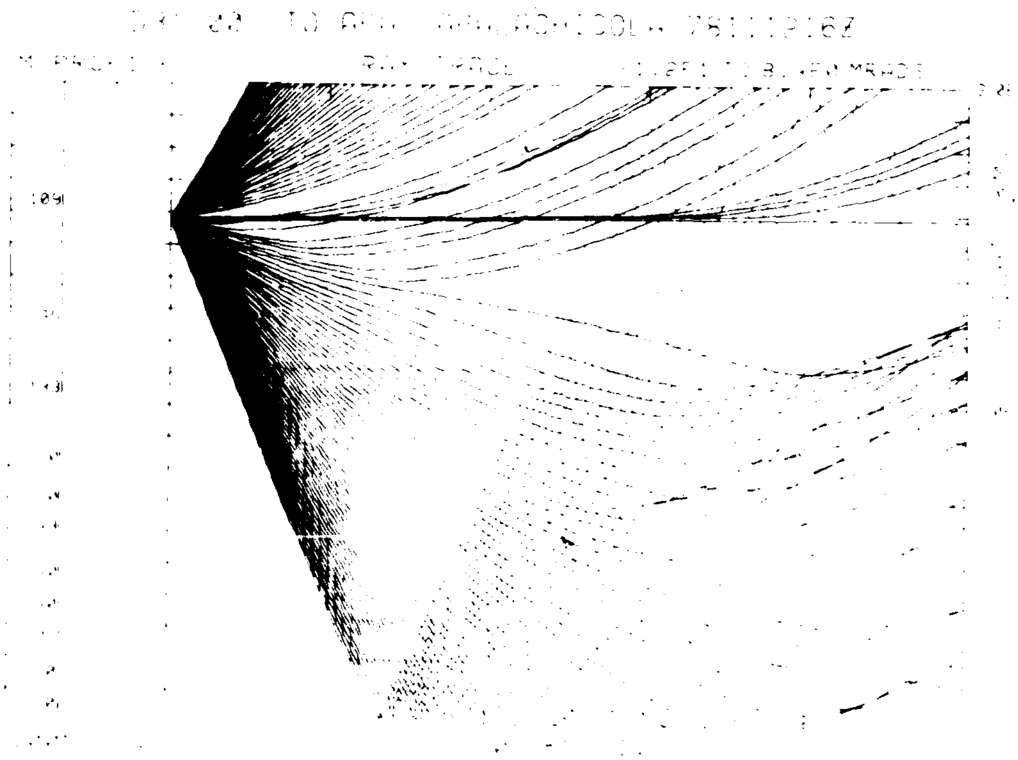


Figure 5-36 . Case 5 Raytrace, D3(500) to APA, Apalachicola 12 Nov 78, 1600Z, Transmitter Height 158.4 m.

CASE 6

1. Case 6 (16 Nov/05-10Z) is a "bad" RSL period on the D3-APA path. Figure 6-1 and 6-2 show typical RSL recording at APA. Note the lack of "painting" with this path.

2. Figures 6-3 through 6-4 indicate that the synoptic pattern for this case is similar to those of previous cases.

3. Tables 6-1 through 6-3 also show similar characteristics to those of surface observations in previous cases.

4. Figures 6-5 and 6-6 show available M-profiles from Cape San Blas and Apalachicola for this period. For Cape San Blas, the 08Z profile indicates a surface-based duct extending to about 70 meters and a relatively smooth, normal-to-near-normal profile above that level. The 10Z profile, however, depicts a somewhat irregular variation in M with no pronounced surface-based duct. Most Apalachicola profiles show a persistent elevated cut below 100 meters and another weaker one centered near the 250-meter level. All profiles once again exemplify the erratic variation of M in the first 300 meters near the coast.

5. Figures 6-7 through 6-24 show the raytrace conditions for the period. Again, when the transmitting antenna is moved to 158.4 meters MSL at D3, the direct ray pattern in the vicinity of the receiver is improved.

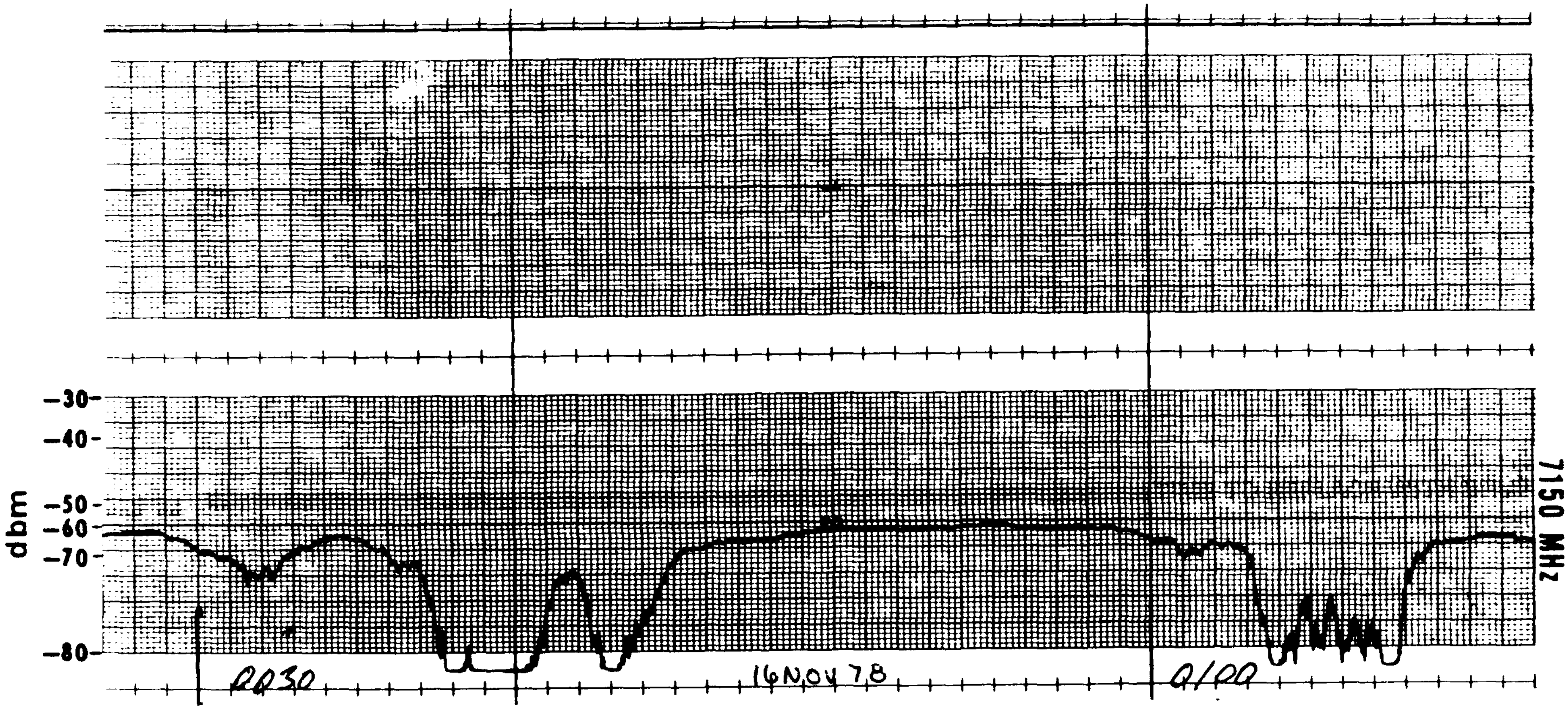


Figure 6-1 Case 6 RSL Strip Chart showing typical fade pattern on single channel (lower graph) of D3 received from APA (channel on upper graph was inoperative). Times are from 0027 EST to 0112 EST, 16 Nov 78. The dbm calibration level is listed on the left, and channel frequency in MHz is listed on the right.

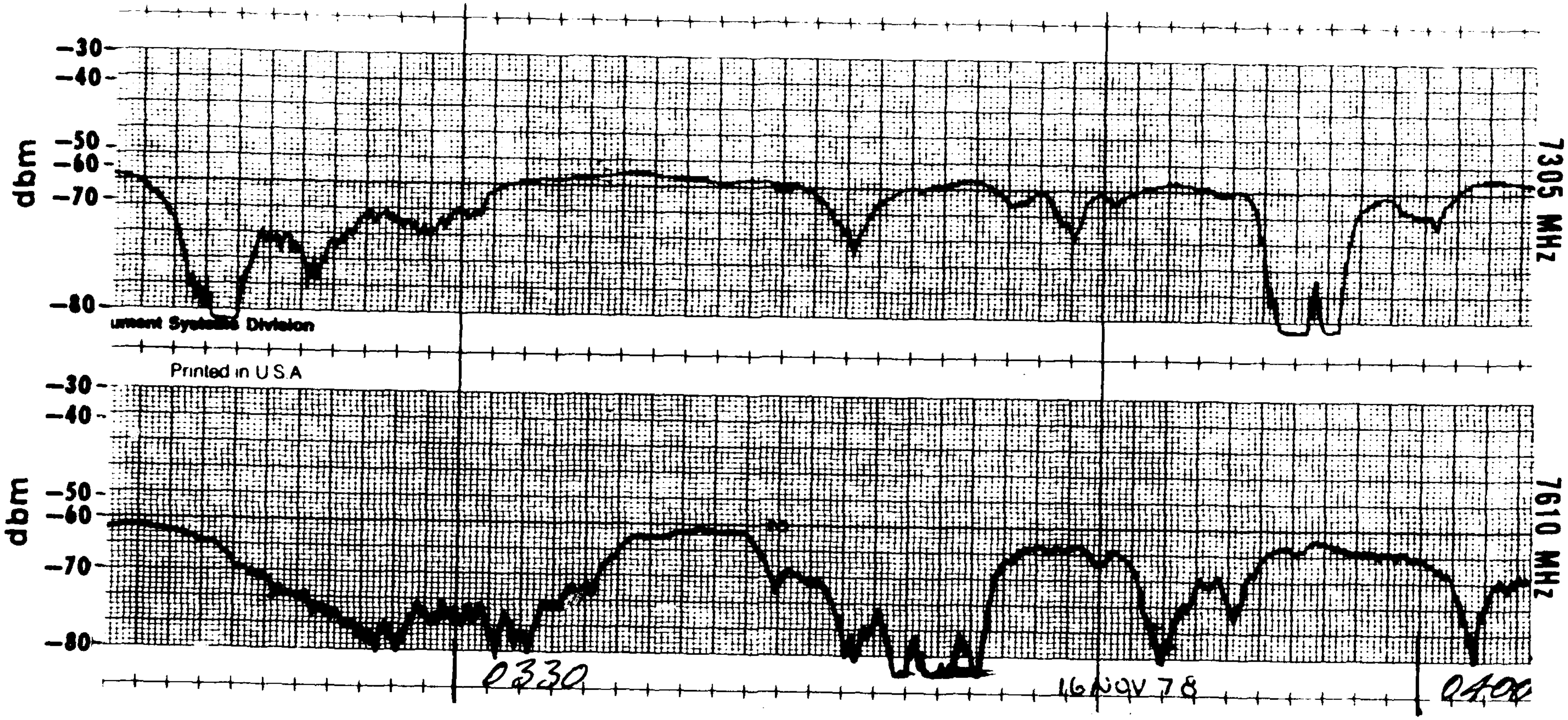


Figure 6-2 Case 6 RSL Strip Chart showing typical fade pattern on both channels of APA received from D3. Times are from 0319 EST to 0403 EST, 16 Nov 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

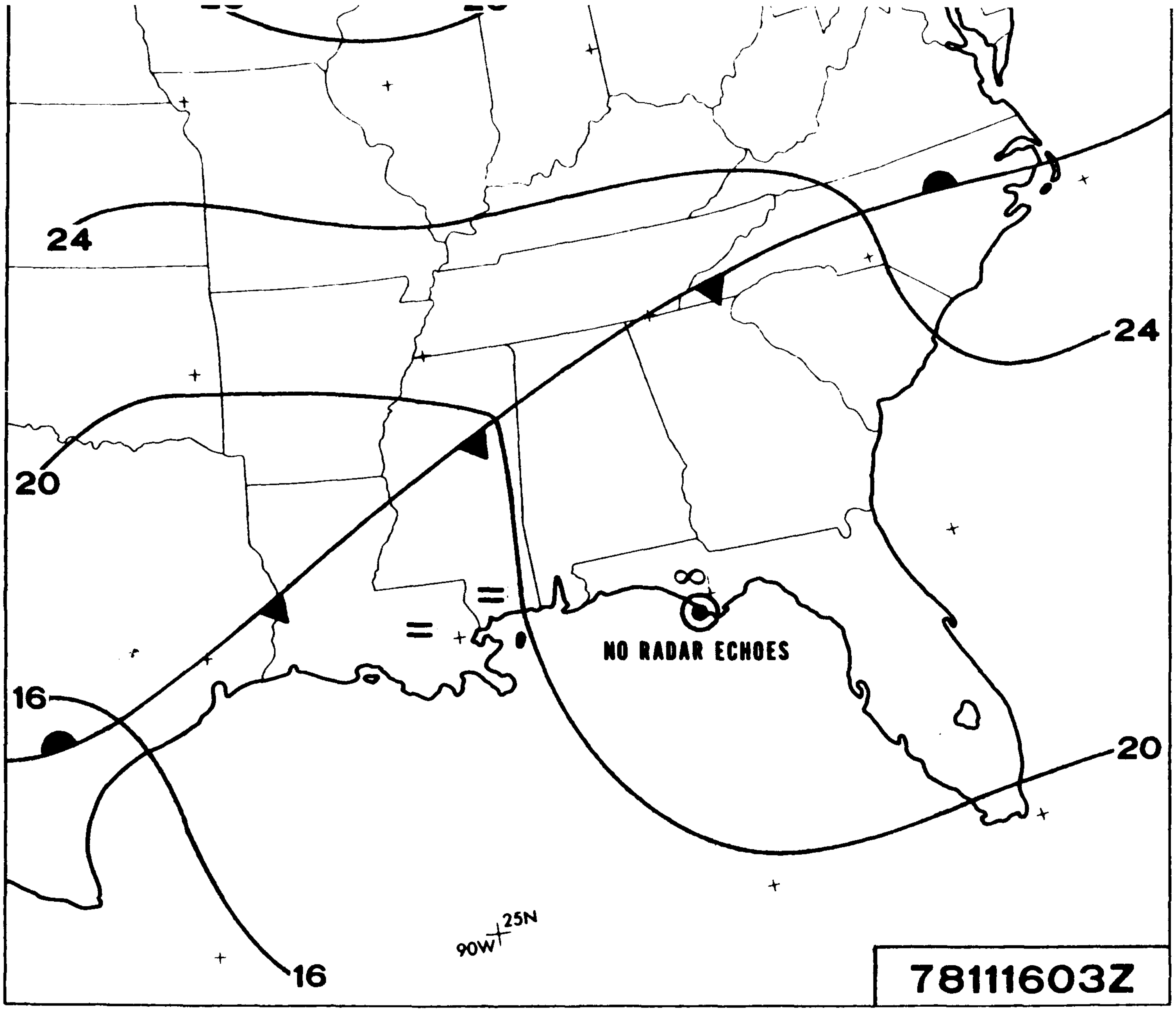


Figure 6-3 78111603Z Synoptic Chart

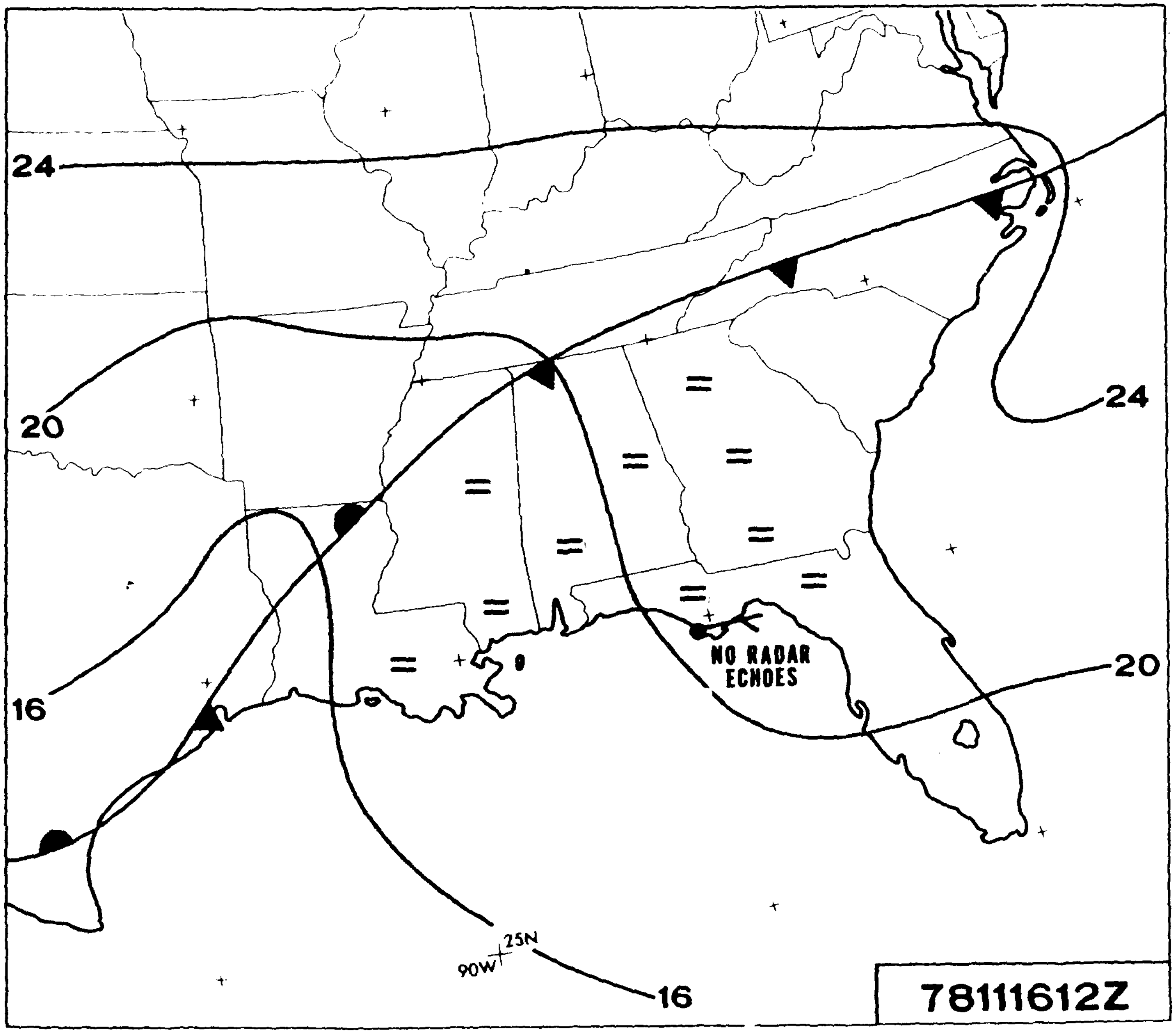


Figure 6-4 78111612Z Synoptic Chart

Table 6-1. Case 6, Apalachicola Surface Weather, 16 Nov 78, 0500Z - 16 Nov 78, 1000Z.

Date-Time (1978) (Z)	Temperature (^{o}C)	Dew-Point Depression (^{o}C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 16 03	18.3	0.5	CALM	CALM	BKN	6	H
06	17.2	1.1	CALM	CALM	SCT	5	F
09	17.2	0.5	120	4	SCT	6	F
12	16.7	0.0	120	3	BKN	5	F
15	23.3	1.6	140	8	BKN	7	None

Table 6-2. Case 6, Tyndall Surface Weather, 16 Nov 78, 0500Z - 16 Nov 78, 1000Z.

Date-Time (1978) (Z)	Temperature (^{o}C)	Dew-Point Depression (^{o}C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 16 03	18.3	3.3	CALM	CALM	SCT	10	None
06	18.3	3.3	CALM	CALM	SCT	10	None
09	17.8	3.4	CALM	CALM	SCT	7	None
12	17.2	2.8	80	2	SCT	7	None
15	21.1	2.8	90	4	OVC	2	F

Table 6-3. Case 6, Eglin Surface Weather, 16 Nov 78, 0500Z - 16 Nov 78, 1000Z.

Date-Time (1978) (Z)	Temperature (^{o}C)	Dew-Point Depression (^{o}C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 16 03	20.6	0.6	CALM	CALM	BKN	7	None
06	18.3	0.5	CALM	CALM	SCT	$2\frac{1}{2}$	F
09	19.4	1.1	CALM	CALM	BKN	3	F
12	17.2	0.5	40	2	SCT	2	F
15	22.8	4.5	60	3	BKN	7	None

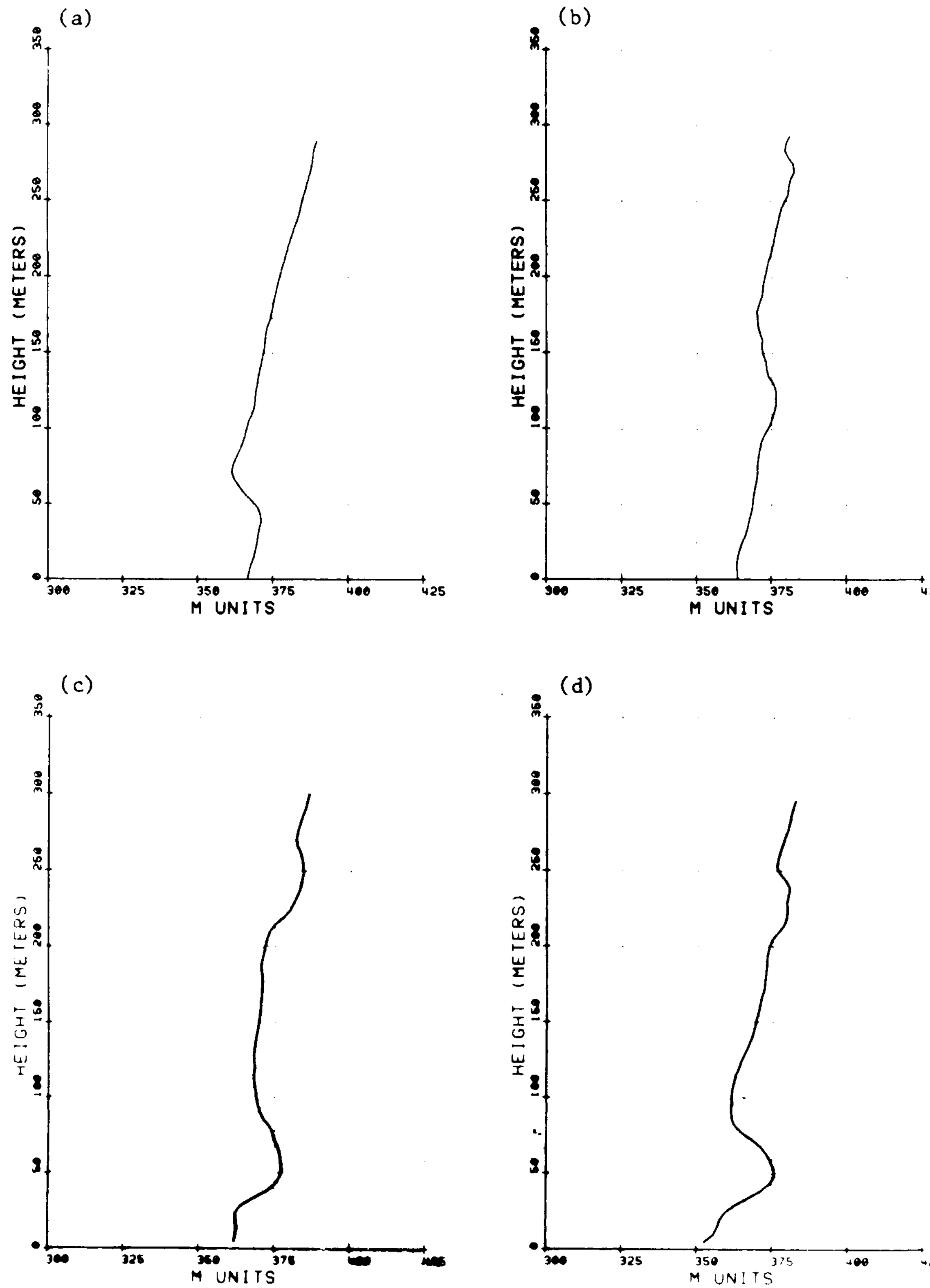


Figure 6-5 Case 6 M-Profiles : a. Cape San Blas, 16 Nov 78, 0800Z; b. Cape San Blas, 16 Nov 78, 1000Z; c. Apalachicola, 16 Nov 78, 0400Z; d. Apalachicola, 16 Nov 78, 0600Z.

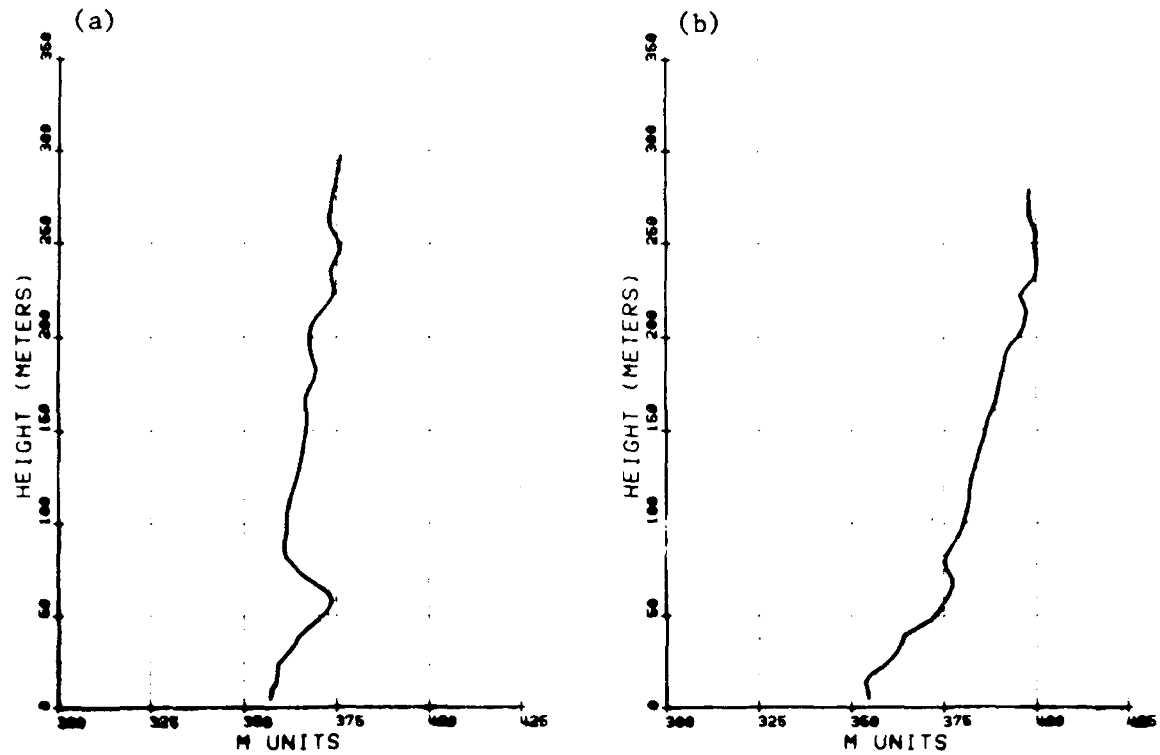


Figure 6-6 Case 6 M-Profiles : a. Apalachicola, 16 Nov 78, 0800Z; b. Apalachicola, 16 Nov 78, 1000Z.

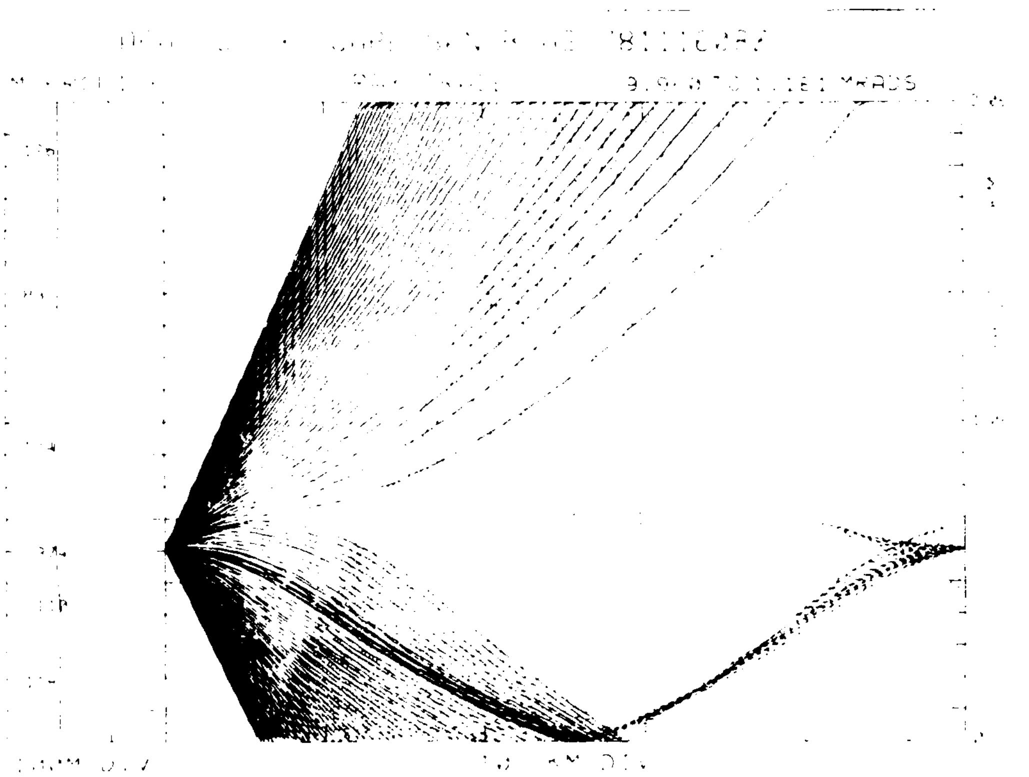


Figure 6-7. Case 6 Raytrace, APA to D3, Cape San Blas, 16 Nov 78, 0800Z, Transmitter Height 61.0 m.

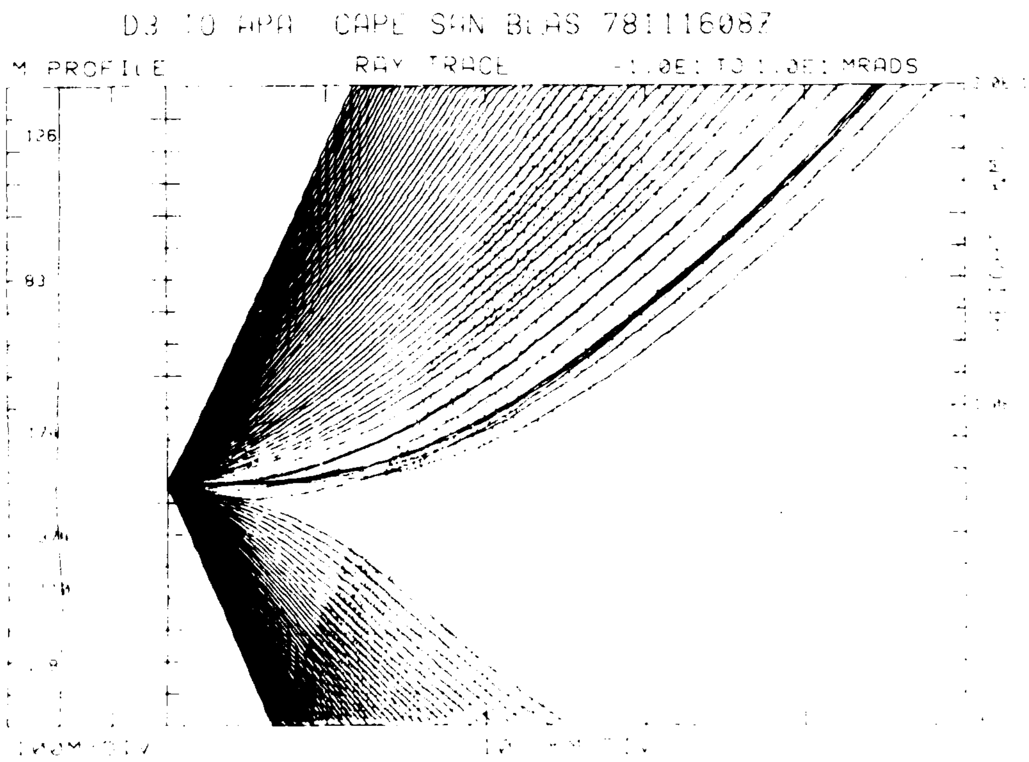


Figure 6-8. Case 6 Raytrace, D3 to APA, Cape San Blas, 16 Nov 78, 0800Z, Transmitter Height 76.2 m.

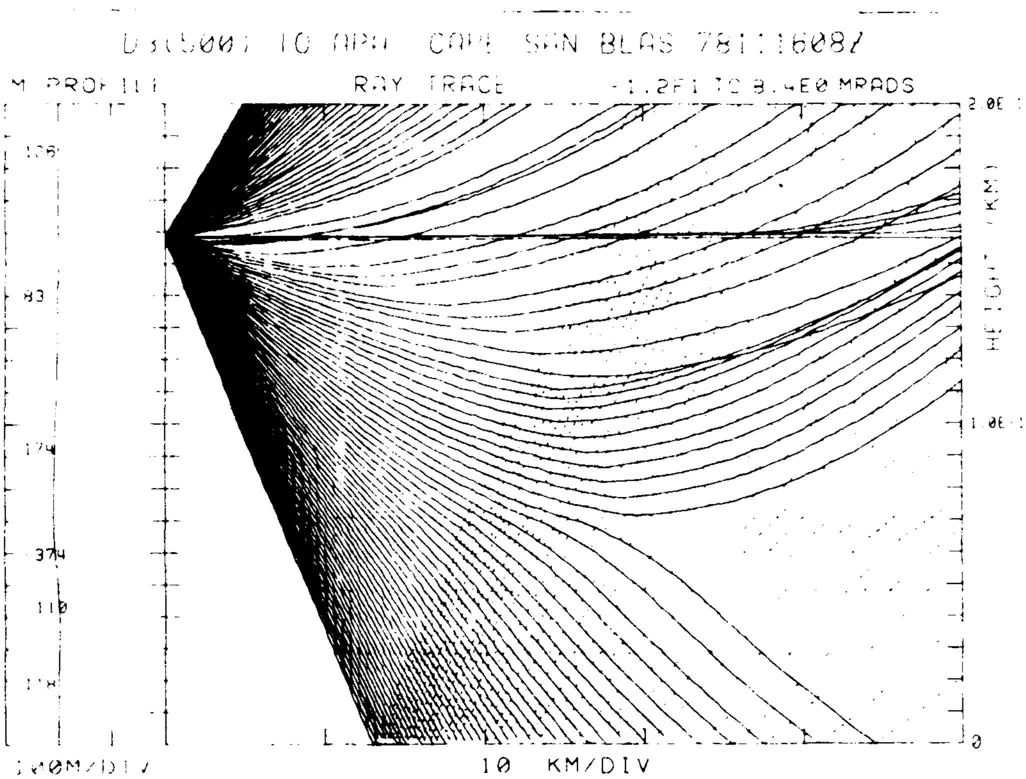


Figure 6-9. Case 6 Raytrace, D3(500) to APA, Cape San Blas 16 Nov 78, 0800Z, Transmitter Height 158.4 m.

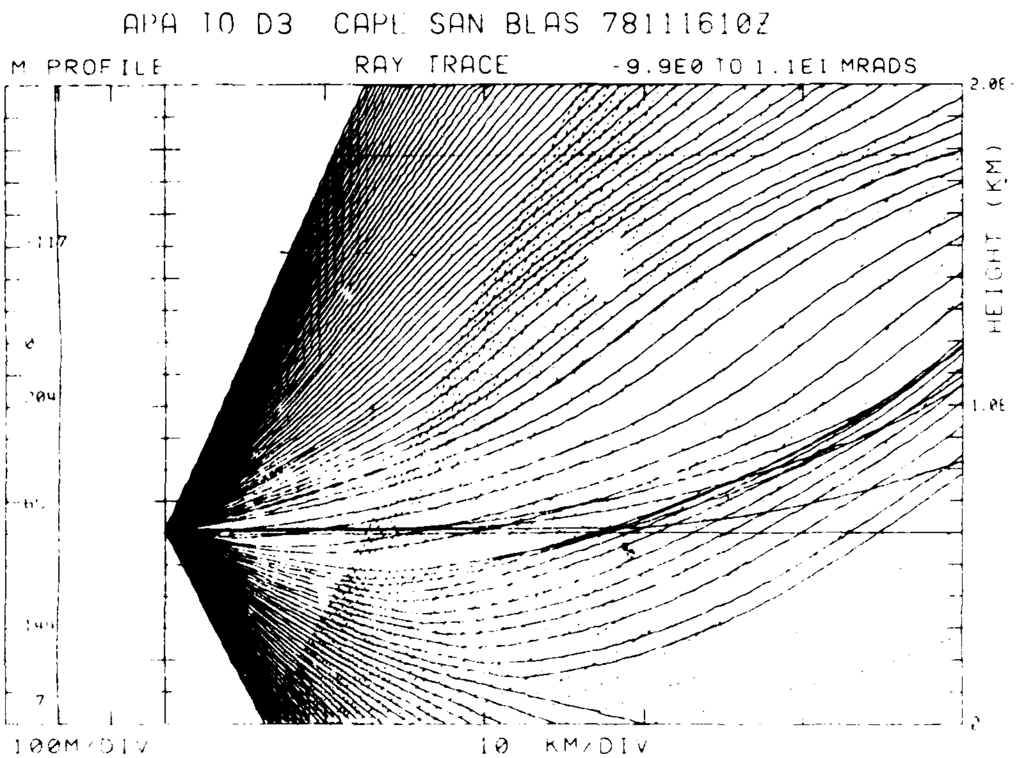


Figure 6-10. Case 6 Raytrace, APA to D3, Cape San Blas, 16 Nov 78, 1000Z, Transmitter Height 61.0 m.

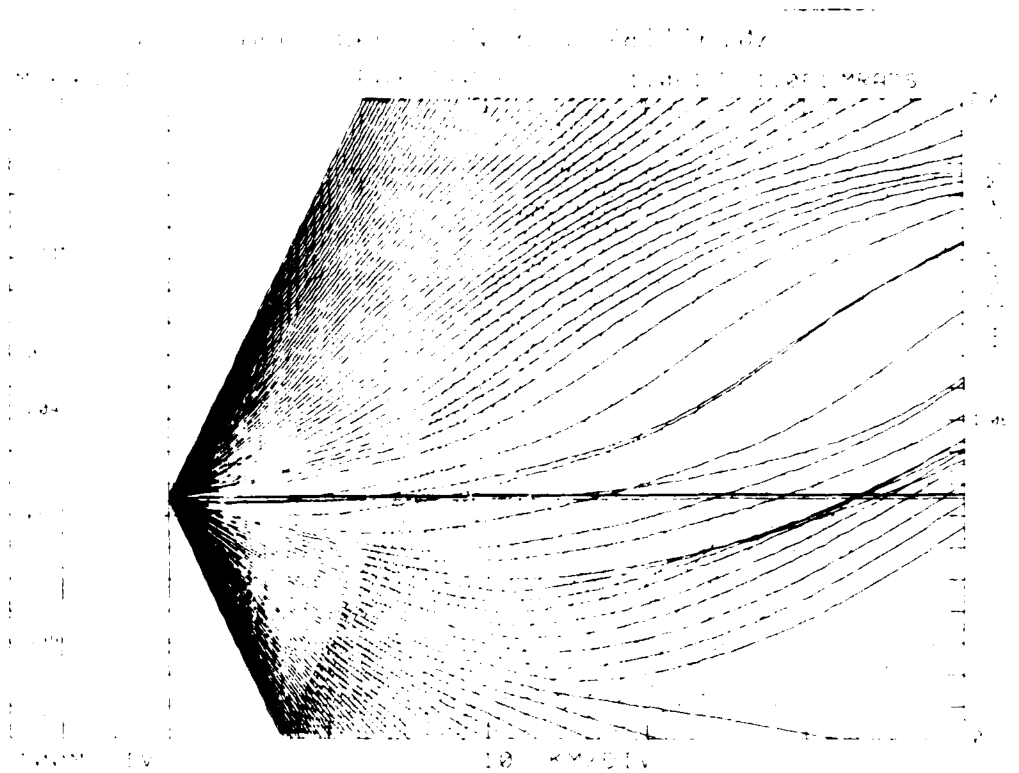


Figure 6-11. Case 6 Raytrace, D3 to APA, Cape San Blas, 16 Nov 78, 1000Z, Transmitter Height 76.2 m.

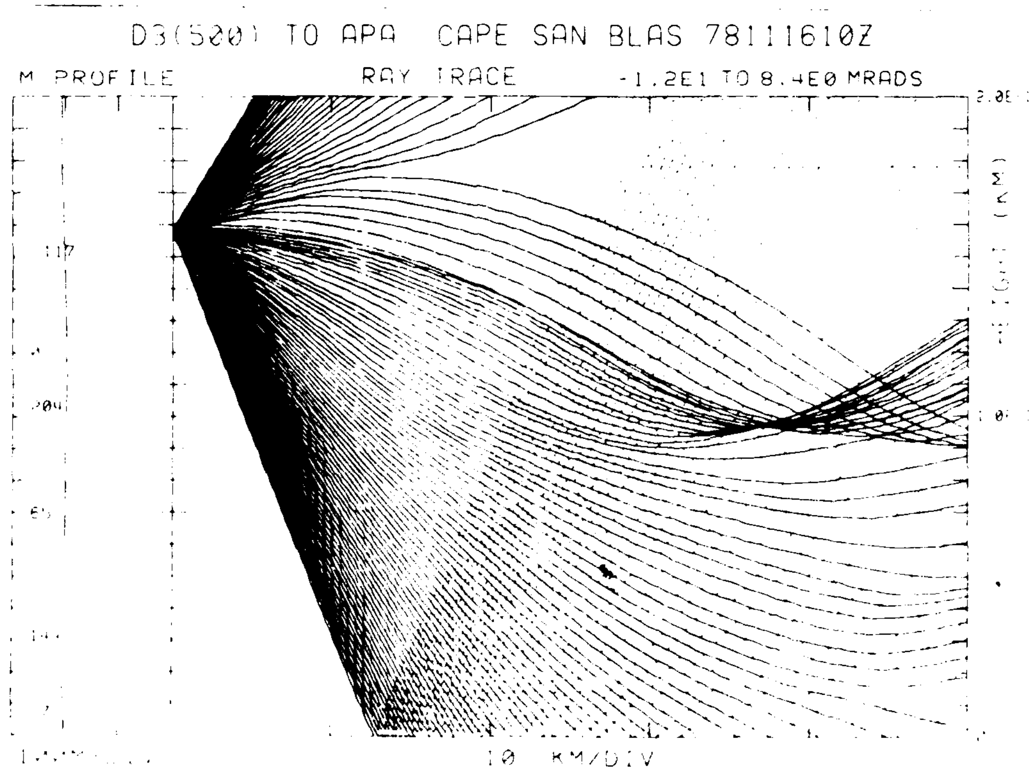


Figure 6-12. Case 6 Raytrace, D3(500) to APA, Cape San Blas 16 Nov 78, 1000Z, Transmitter Height 158.4 m.

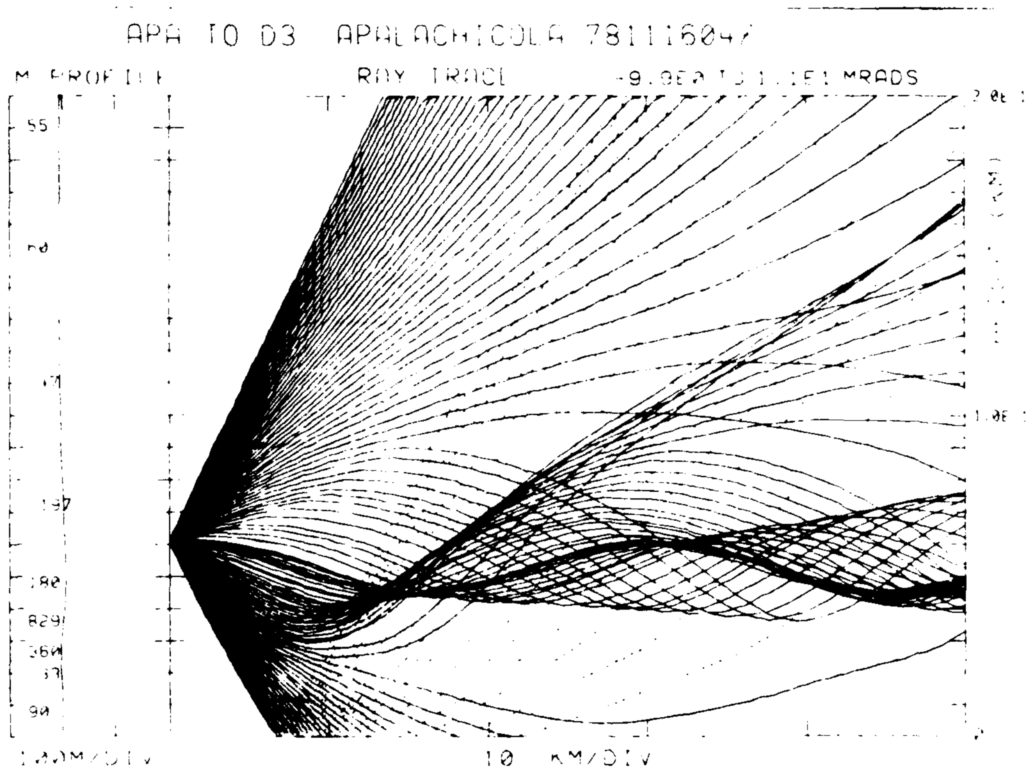


Figure 6-13. Case 6 Raytrace, APA to D3, Apalachicola, 16 Nov 78, 0400Z, Transmitter Height 61.0 m.

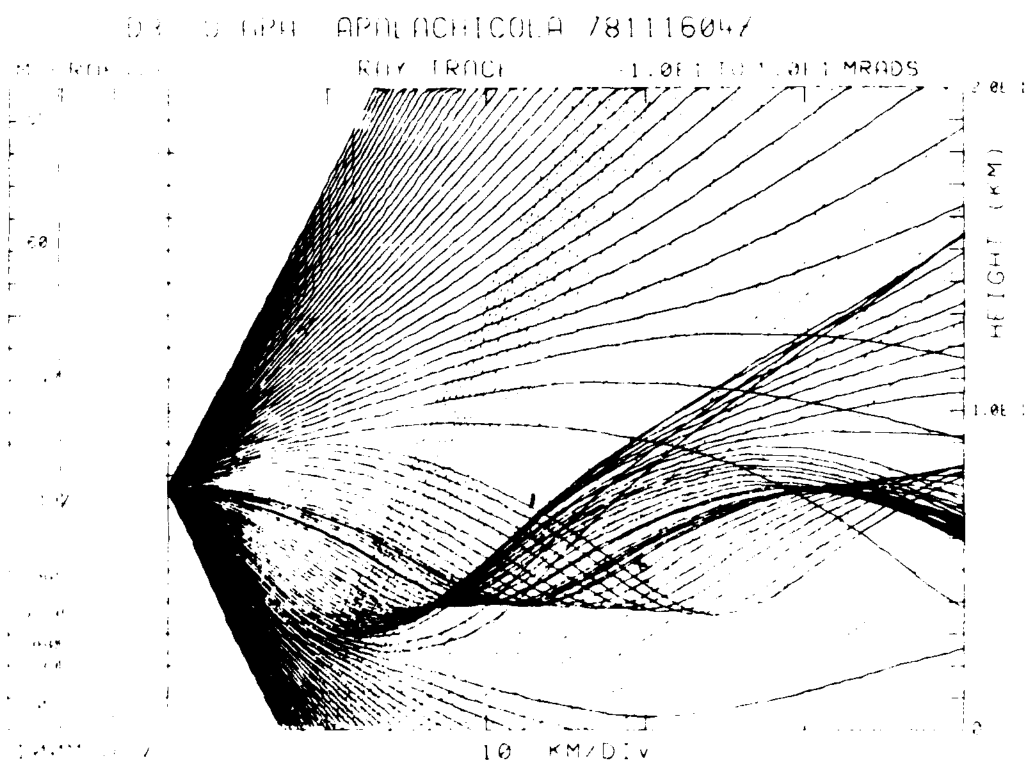


Figure 6-14. Case 6 Raytrace, D3 to APA, Apalachicola, 16 Nov 78, 0400Z, Transmitter Height 76.2 m.

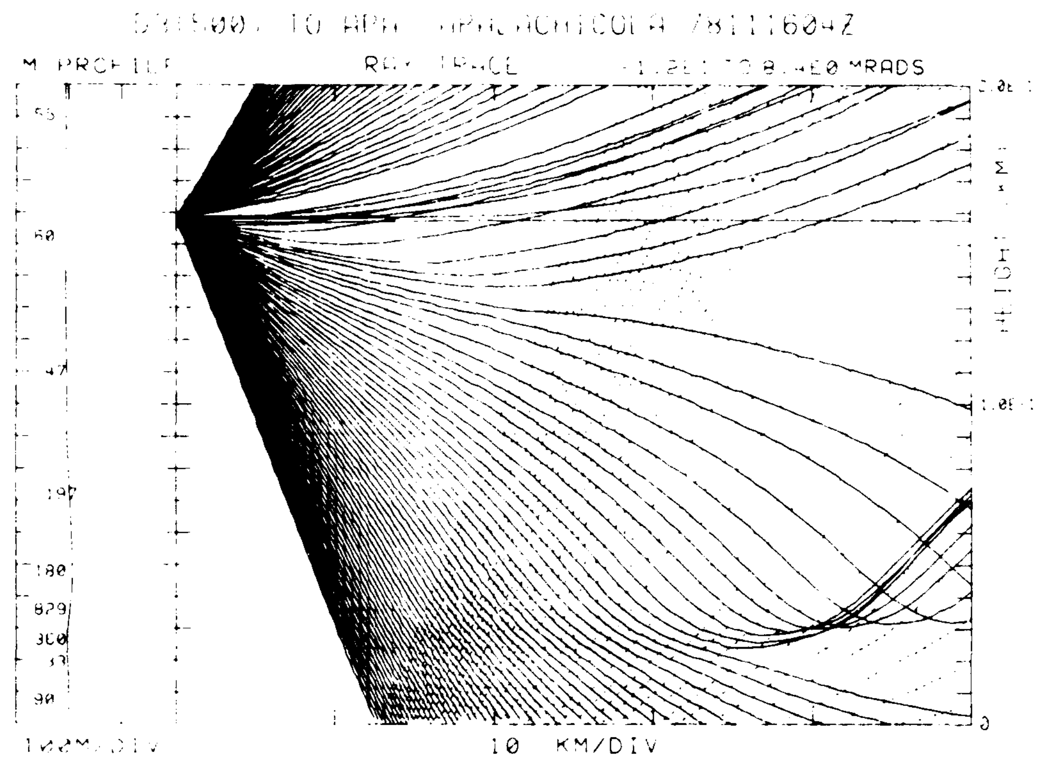


Figure 6-15. Case 6 Raytrace, D3(500) to APA, Apalachicola 16 Nov 78, 0400Z, Transmitter Height 158.4 m.

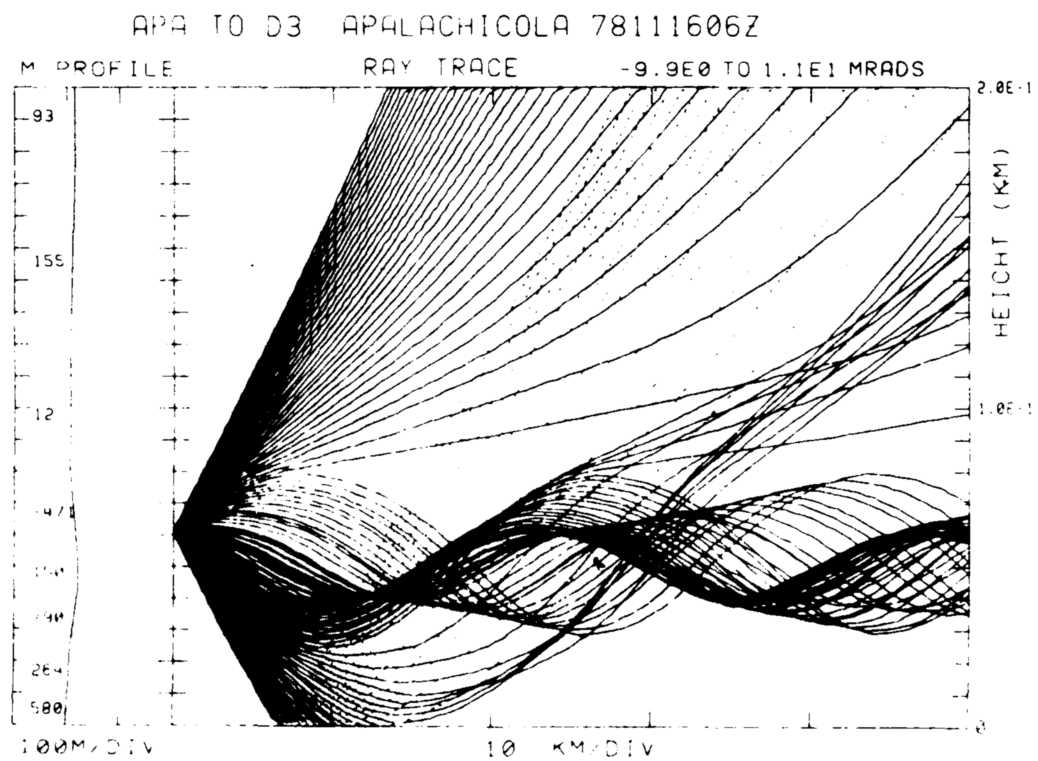


Figure 6-16. Case 6 Raytrace, APA to D3, Apalachicola, 16 Nov 78, 0600Z, Transmitter Height 61.0 m.

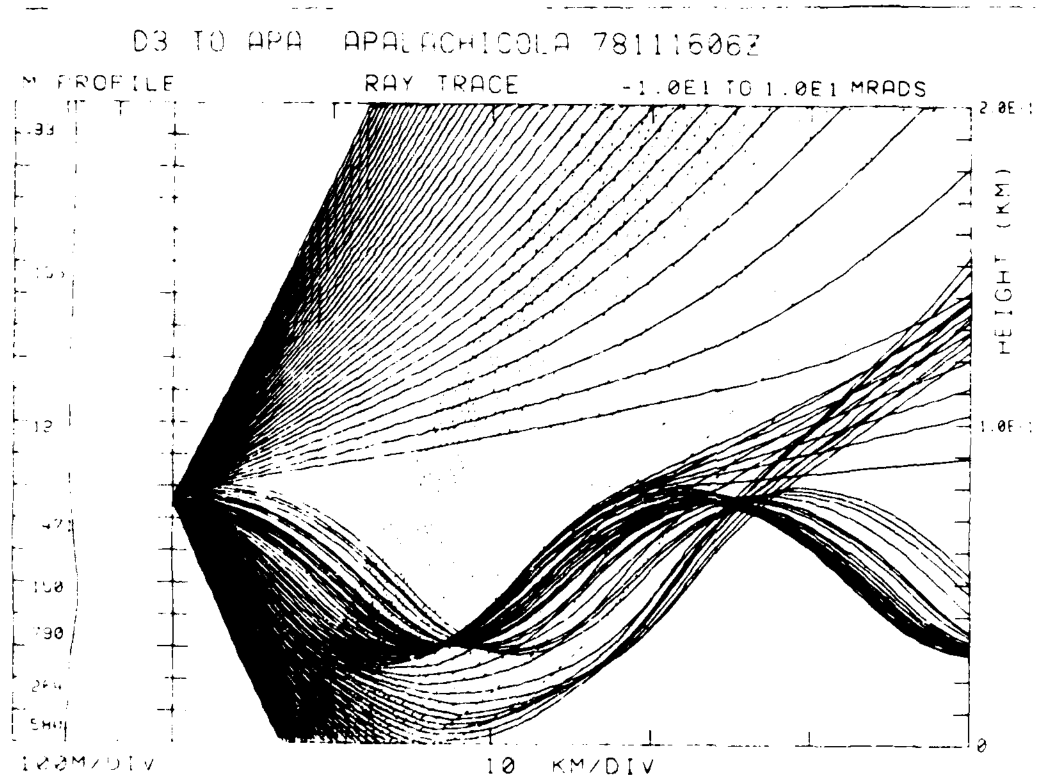


Figure 6-17. Case 6 Raytrace, D3 to APA, Apalachicola, 16 Nov 78, 0600Z, Transmitter Height 76.2 m.

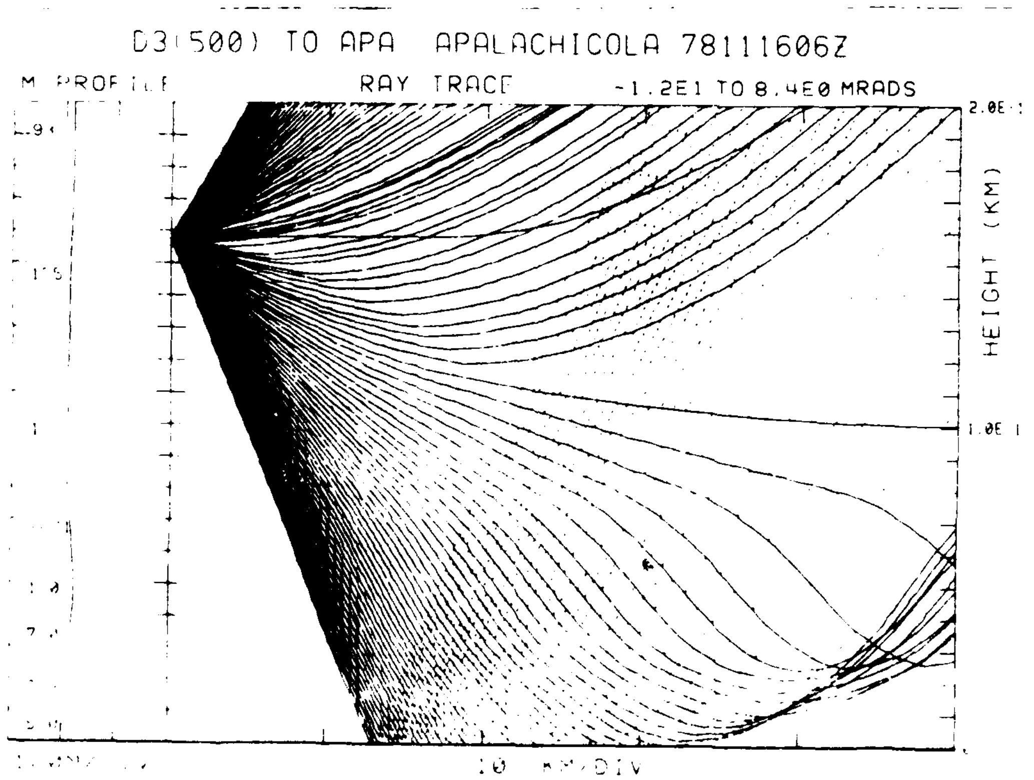


Figure 6-18. Case 6 Raytrace, D3(500) to APA, Apalachicola 16 Nov 78, 0600Z, Transmitter Height 158.4 m.

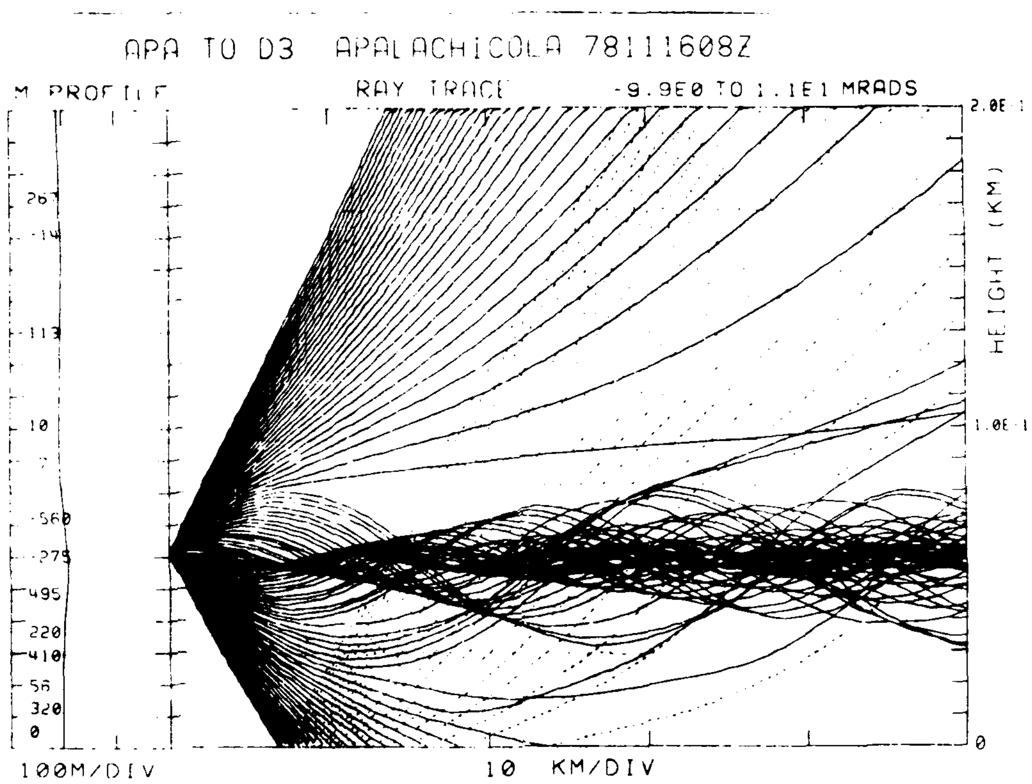


Figure 6-19. Case 6 Raytrace, APA to D3, Apalachicola, 16 Nov 78, 0800Z, Transmitter Height 61.0 m.

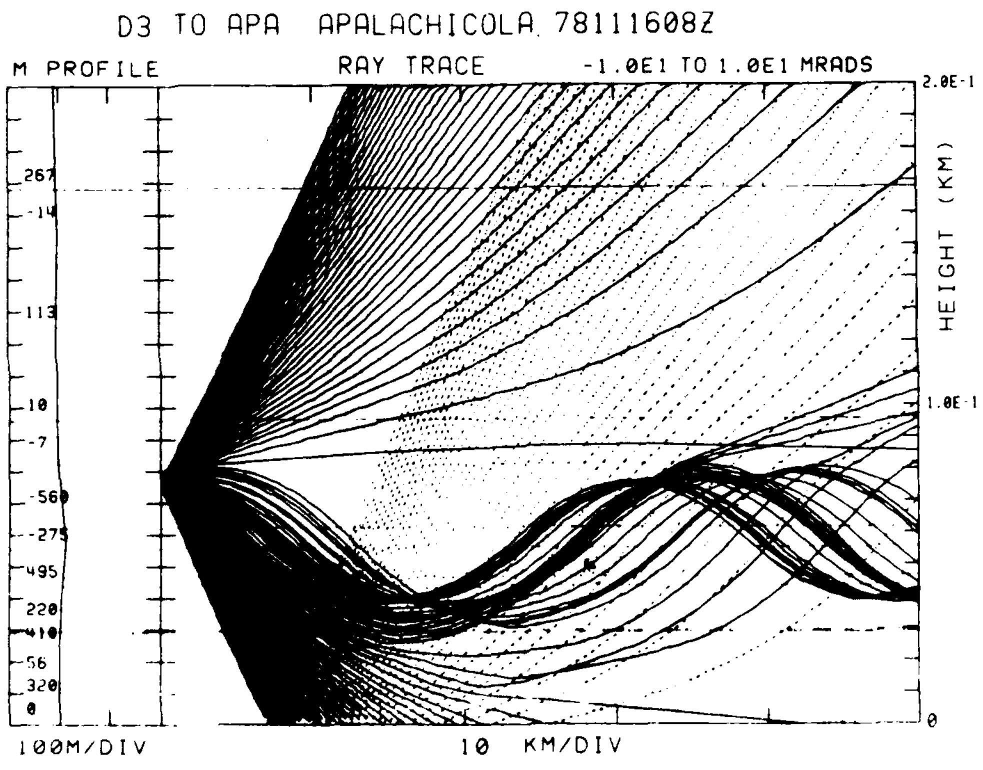


Figure 6-20. Case 6 Raytrace, D3 to APA, Apalachicola, 16 Nov 78, 0800Z, Transmitter Height 76.2 m.

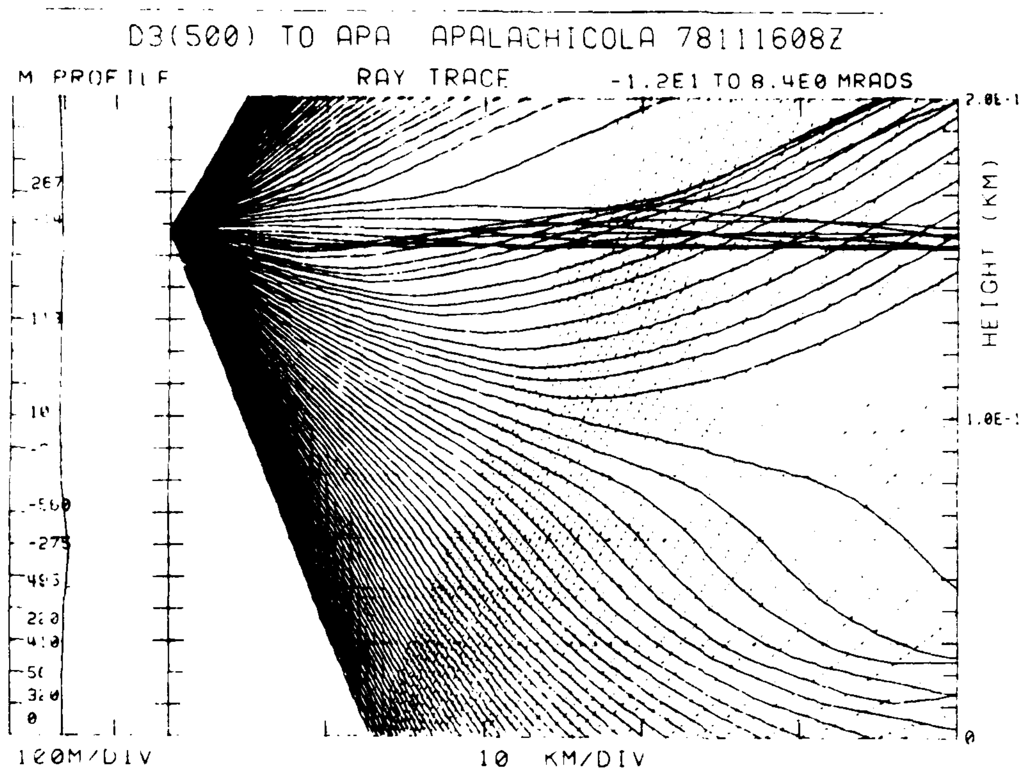


Figure 6-21. **Case 6 Raytrace, D3(500) to APA, Apalachicola 16 Nov 78, 0800Z, Transmitter Height 158.4 m.**

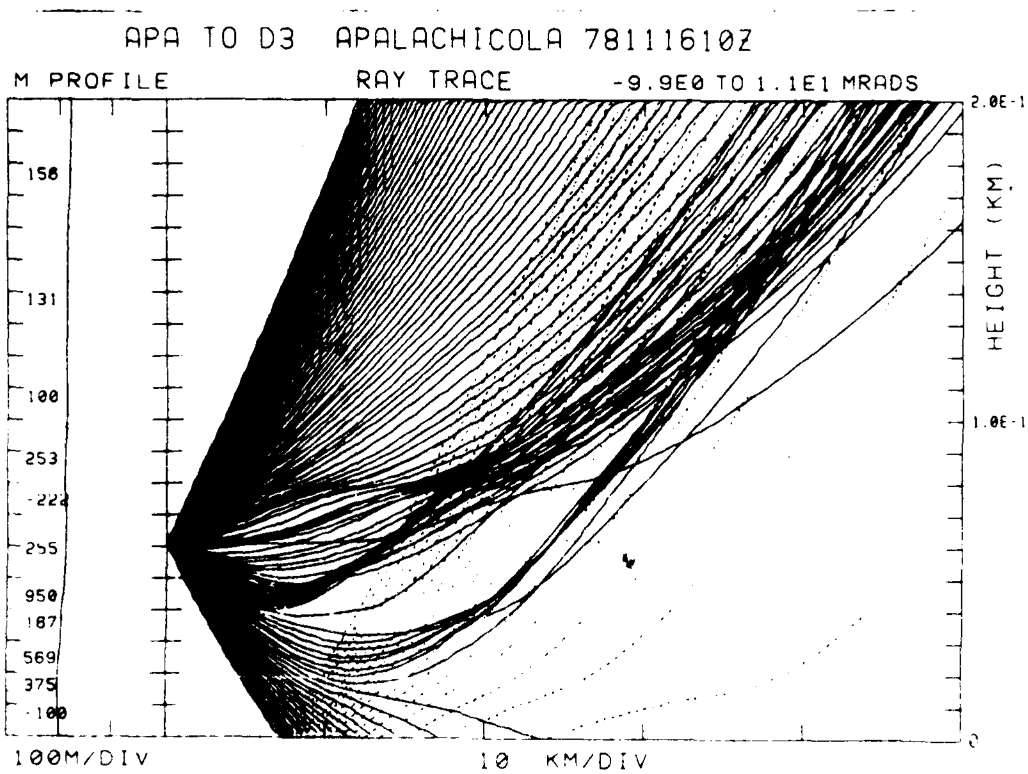


Figure 6-22. **Case 6 Raytrace, APA to D3, Apalachicola, 16 Nov 78, 1000Z, Transmitter Height 61.0 m.**

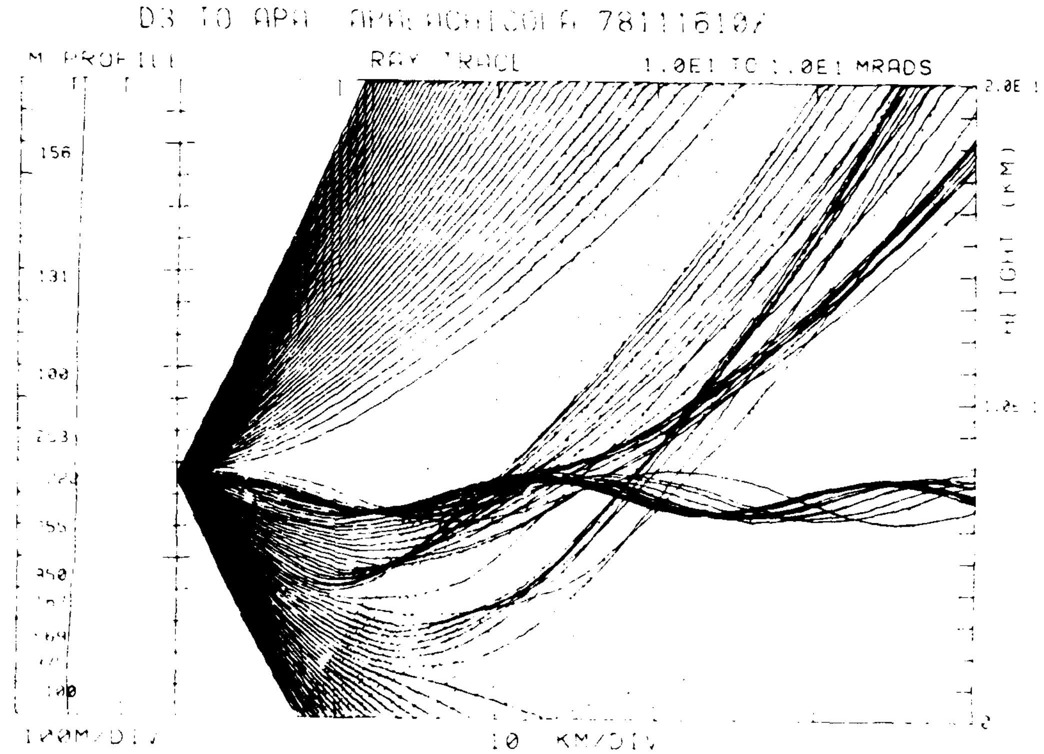


Figure 6-23. Case 6 Raytrace, D3 to APA, Apalachicola, 16 Nov 78, 1000Z, Transmitter Height 76.2 m.

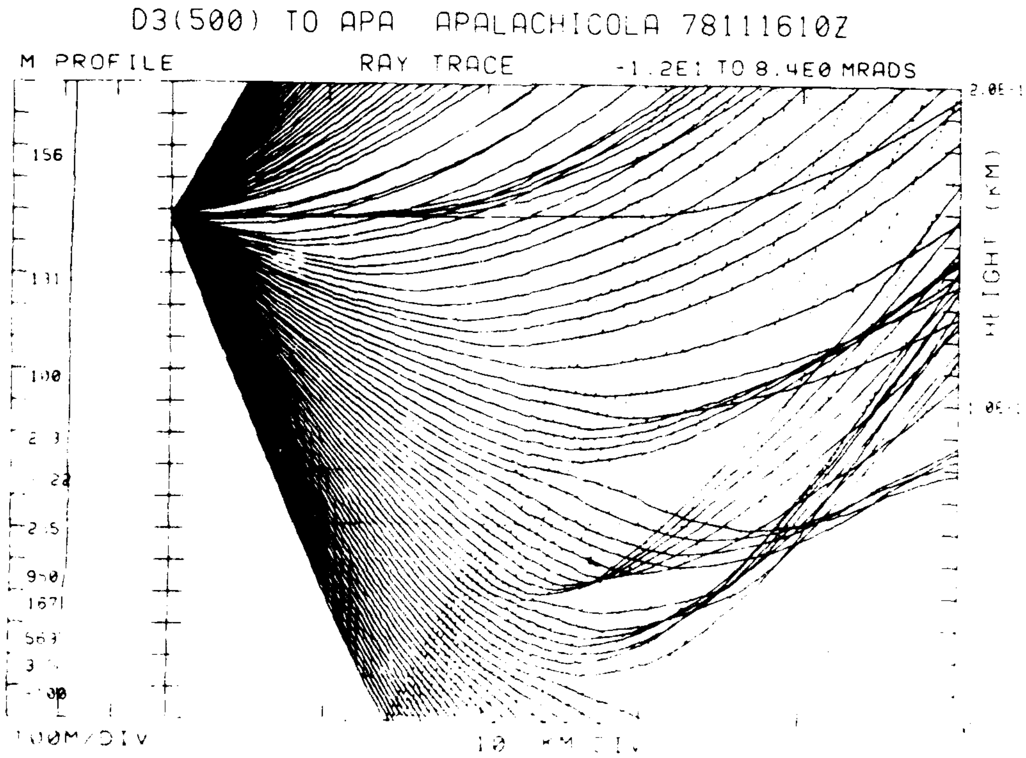


Figure 6-24. Case 6 Raytrace, D3(500) to APA, Apalachicola 16 Nov 78, 1000Z, Transmitter Height 158.4 m.

CASE 7

1. Case 7 (23 Nov/01-11Z) is the final poor propagation period examined; it is based on the RSL recordings at APA as transmitted from D3. Typical RSL readings are shown in Figure 7-1.

2. The synoptic pattern (Figures 7-2 through 7-4) shows a weak pressure gradient, a lack of precipitation, and calm-to-light surface winds in the area of interest.

3. The surface observations in Tables 7-1 through 7-3 indicate calm-to-light winds with a weak sea-breeze formation in the late morning. Fog reduced visibility in early morning.

4. M-profiles for Cape San Blas and Apalachicola are shown in Figures 7-5 and 7-6. Although no significant trend in the profile patterns is obvious, slightly smoother vertical changes in M appear above 200-250 meters (for those profiles that reach near 300 meters).

5. The raytrace for this case (Figures 7-7 through 7-24) shows marked improvement when the 158.4 meter MSL transmitting antenna at D3 was used (especially in terms of ray density and at closer ranges).

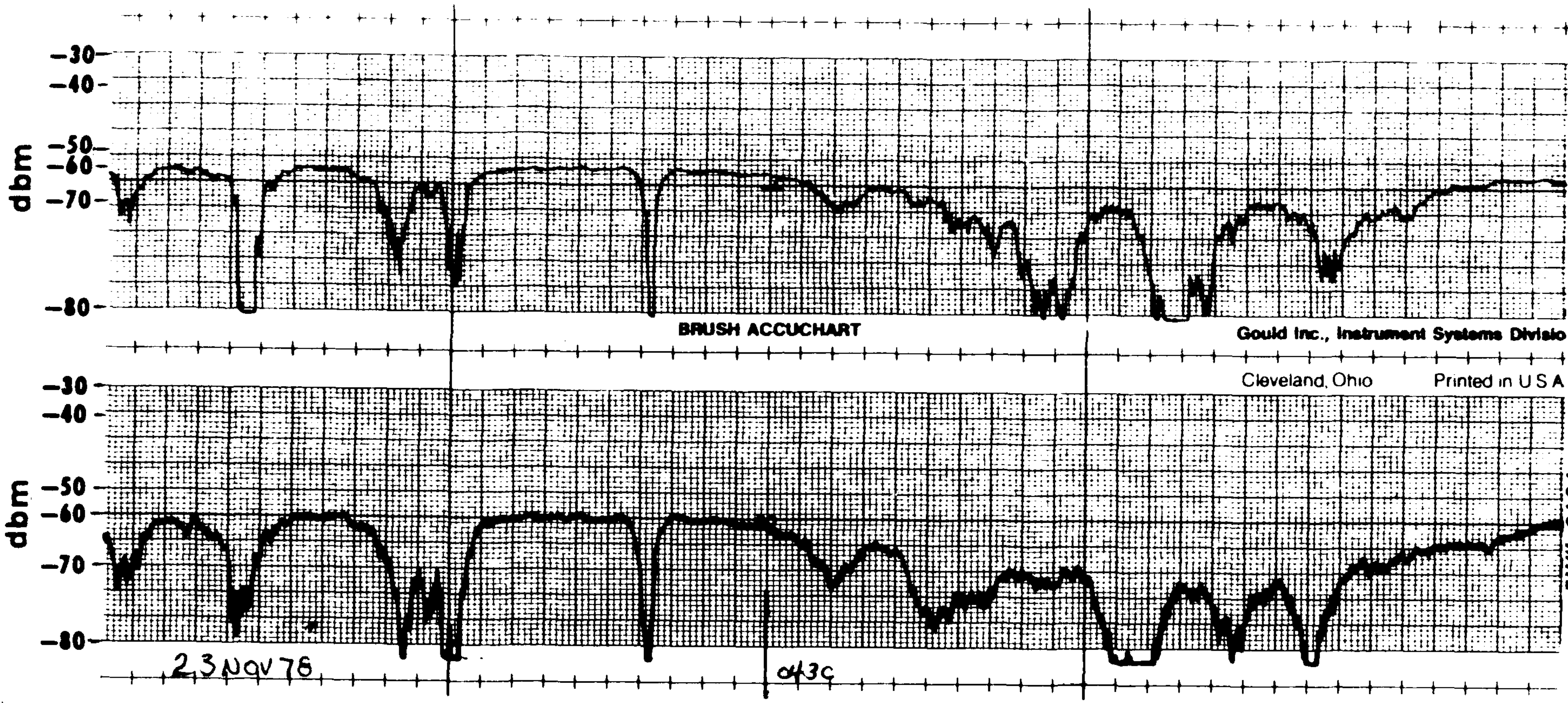


Figure 7-1 Case 7 RSL Strip Chart showing typical fade pattern on both channels of APA received from D3. Times are from 0409 EST to 0455 EST, 23 Nov 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

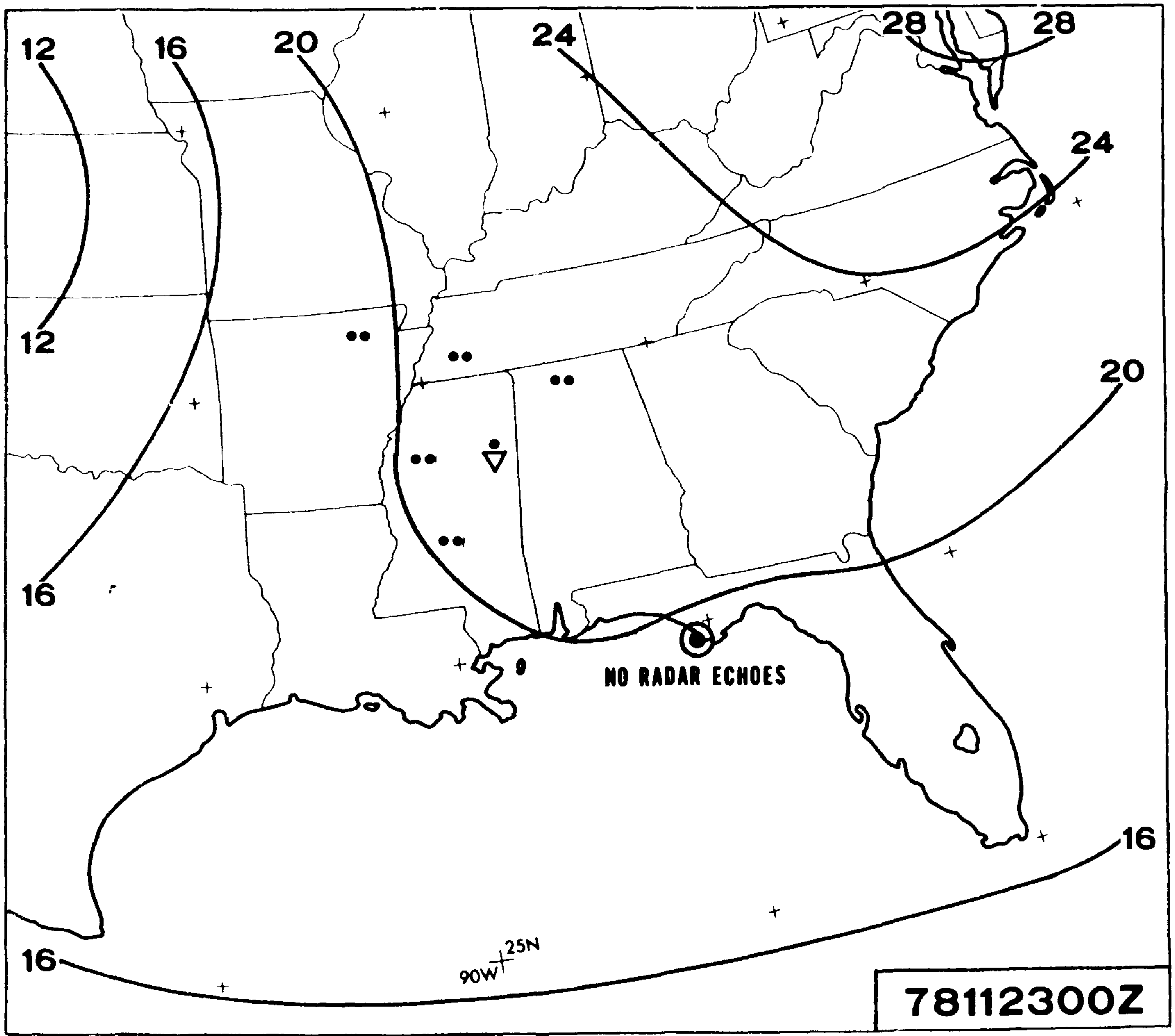


Figure 7-2 78112300Z Synoptic Chart

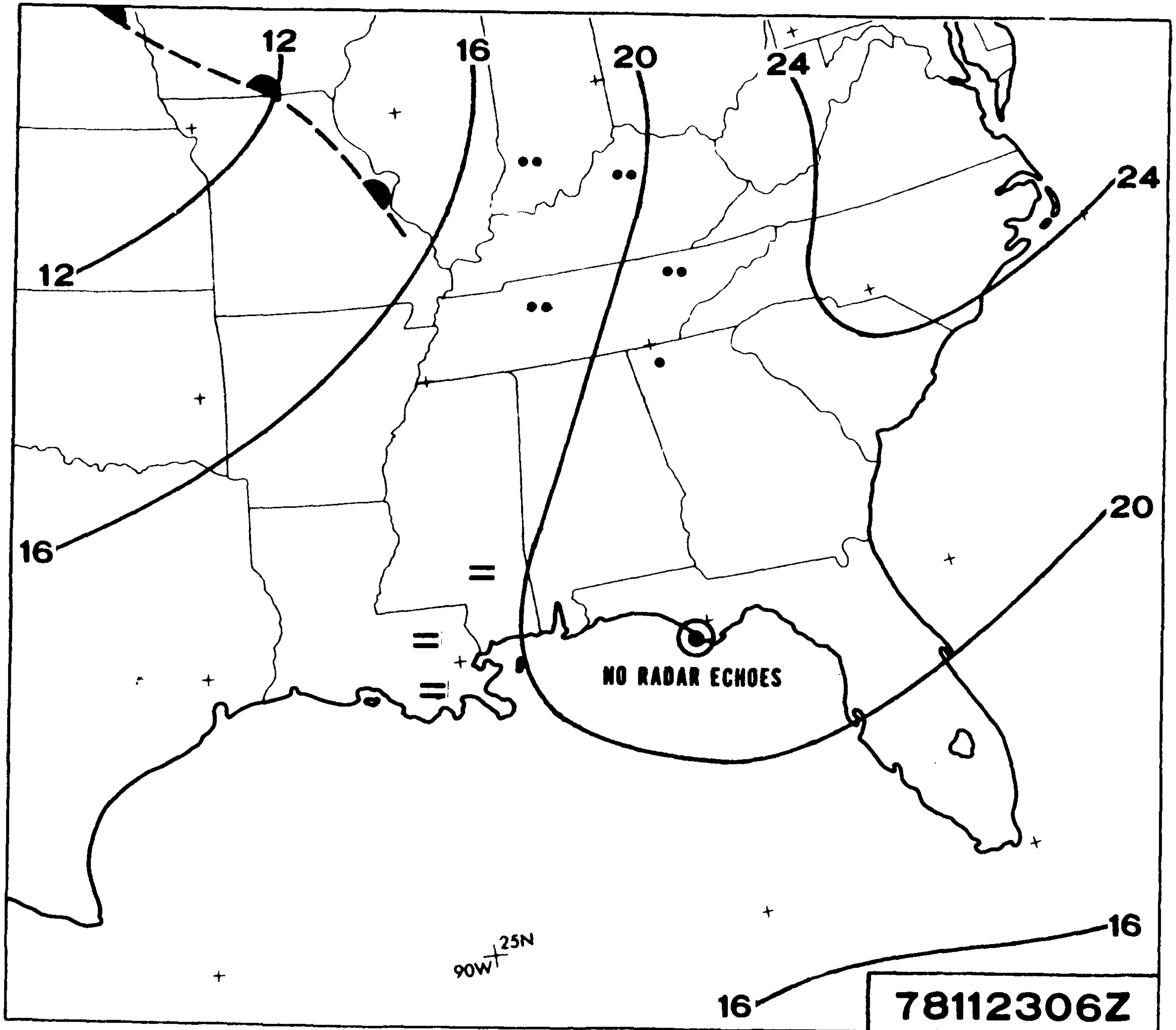


Figure 7-3 78112306Z Synoptic Chart

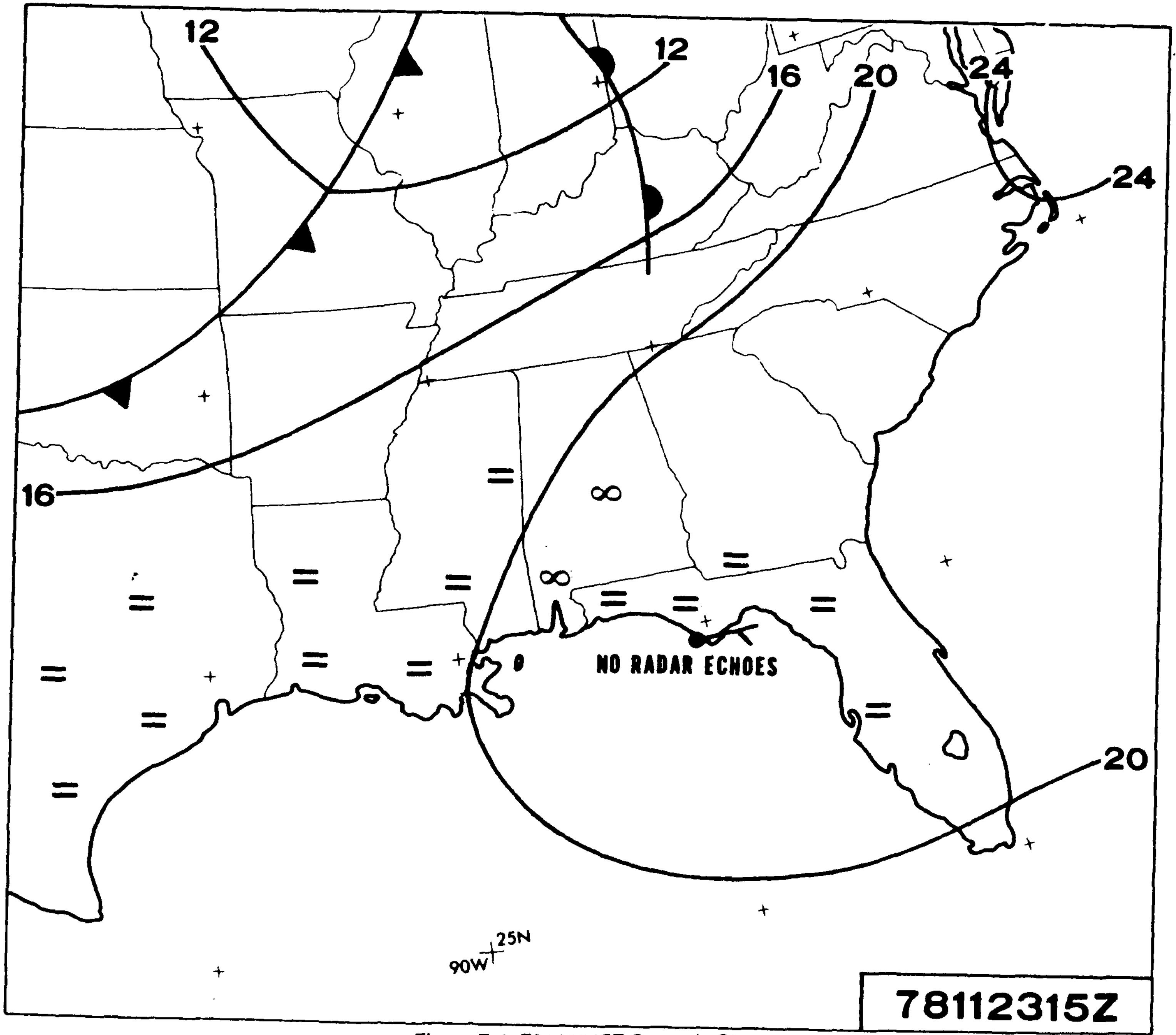


Figure 7-4 78112315Z Synoptic Chart

Table 7-1. Case 7, Apalachicola Surface Weather, 23 Nov 78, 0100Z - 23 Nov 78, 1100Z.

Date-Time (1978) (Z)	Temperature (^oC)	Dew-Point Depression (^oC)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 23 00	16.7	0.6	340	3	SCT	7	None
03	15.0	0.0	CALM	CALM	SCT	7	None
06	15.6	0.6	340	5	SCT	7	None
09	15.0	0.6	340	3	CLR	7	None
12	14.4	0.5	340	3	SCT	2	GF
15	21.1	2.2	150	8	OVC	7	None

Table 7-2. Case 7, Tyndall Surface Weather, 23 Nov 78, 0100Z - 23 Nov 78, 1100Z.

Date-Time (1978) (Z)	Temperature (^oC)	Dew-Point Depression (^oC)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 23 00	20.6	6.2	CALM	CALM	CLR	7	None
03	17.8	3.9	CALM	CALM	SCT	7	None
06	15.6	3.4	CALM	CALM	CLR	7	None
07	15.0	3.9	CALM	CALM	SCT	3	F
09	13.3	3.3	CALM	CALM	--	3	F
12	14.4	3.3	90	1	BKN	5	F
15	20.0	3.3	90	5	BKN	3	F
16	22.8	5.0	120	5	BKN	7	None

Table 7-3. Case 7, Eglin Surface Weather, 23 Nov 78, 0100Z - 23 Nov 78, 1100Z.

Date-Time (1978) (Z)	Temperature (^oC)	Dew-Point Depression (^oC)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 23 00	19.4	3.3	CALM	CALM	BKN	8	None
03	16.7	1.7	CALM	CALM	BKN	9	None
06	15.0	0.0	CALM	CALM	CLR	7	None
09	14.4	0.5	CALM	CALM	SCT	7	None
12	15.6	1.2	CALM	CALM	OVC	7	None
15	20.0	4.4	40	1	SCT	10	None

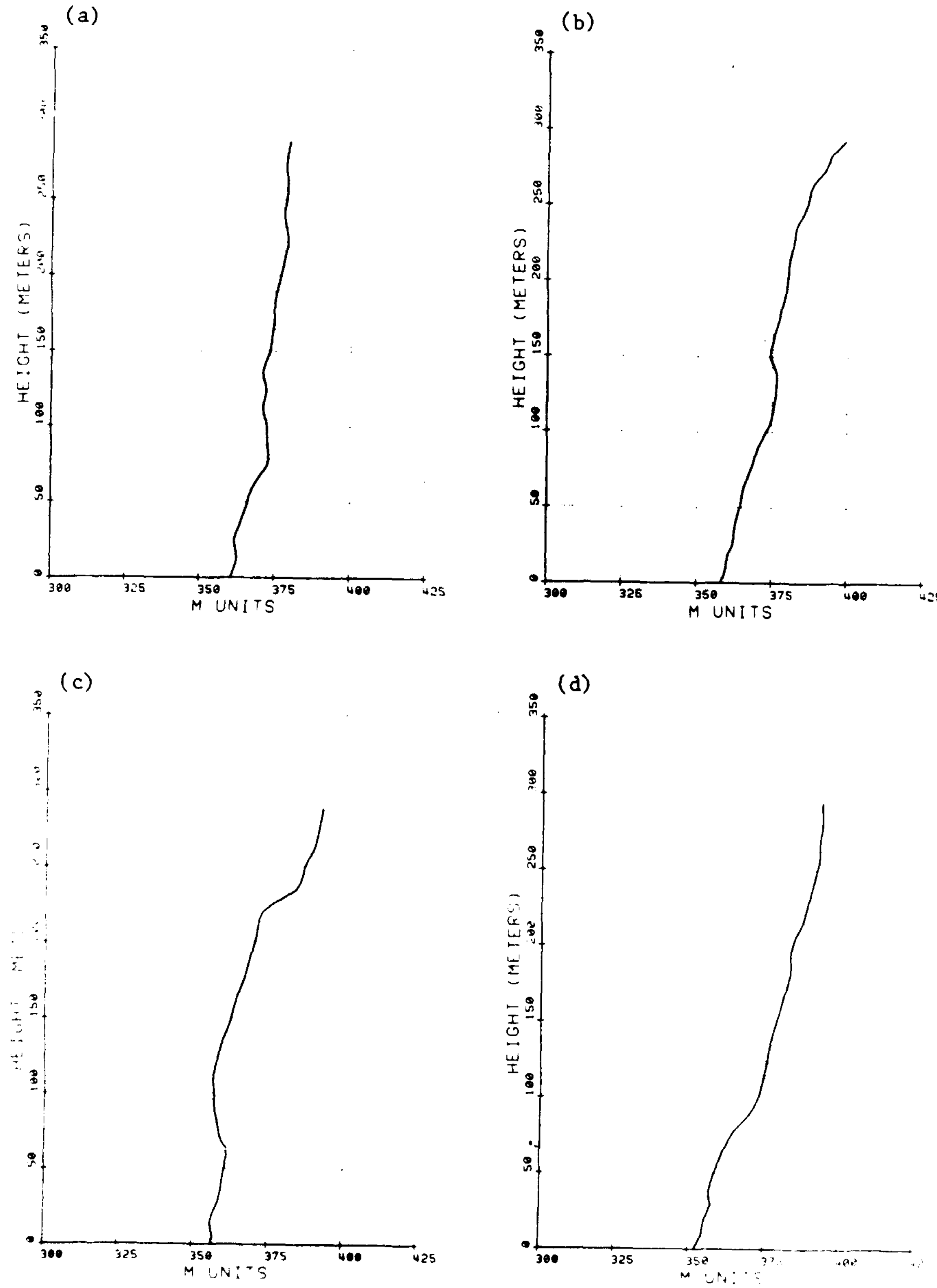


Figure 7-5 Case 7 M-Profiles : a. Cape San Blas, 23 Nov 78, 0900Z; b. Cape San Blas, 23 Nov 78, 1000Z; c. Cape San Blas 23 Nov 78, 1100Z; d. Cape San Blas, 23 Nov 78, 1200Z.

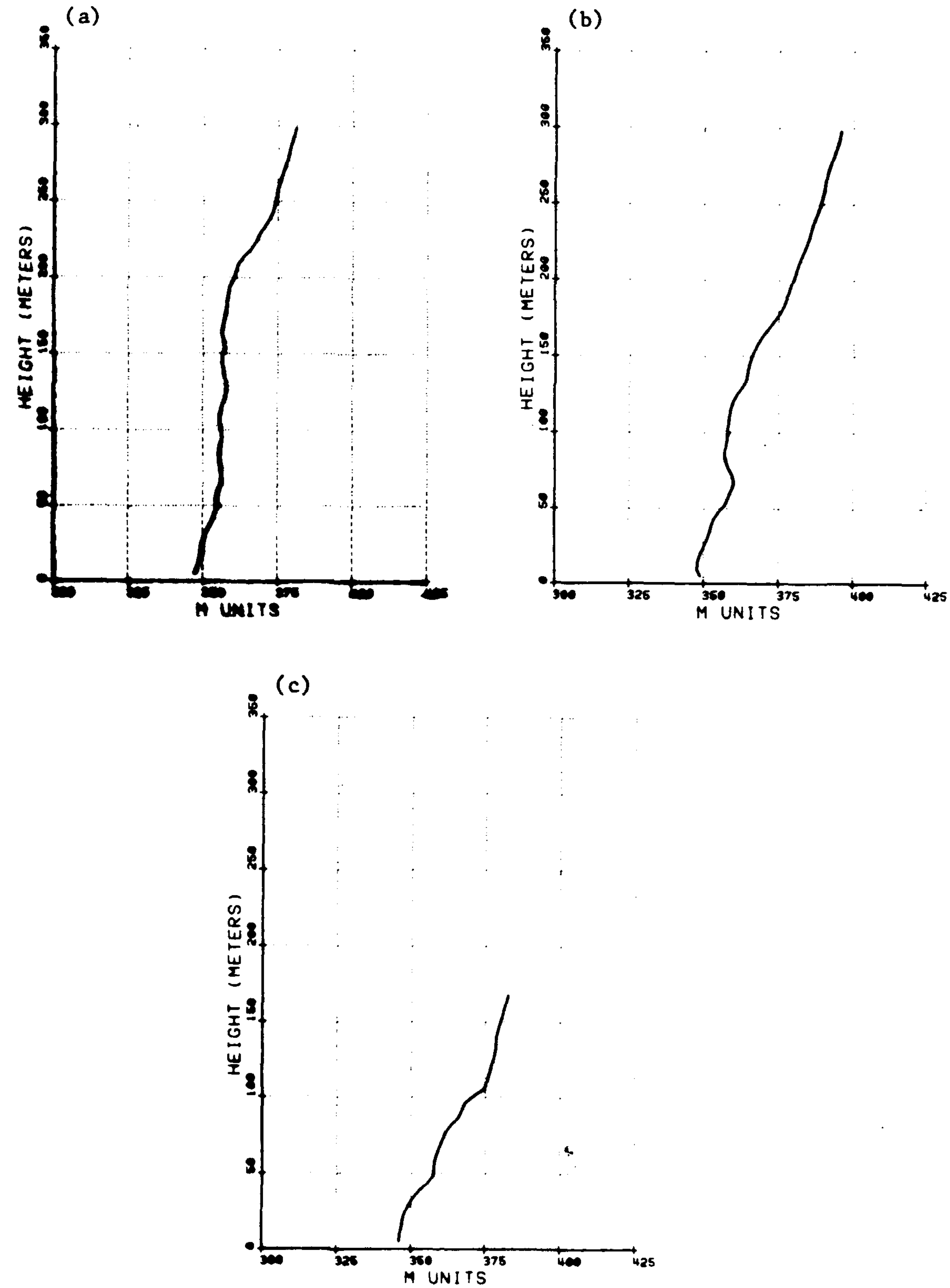


Figure 7-6 Case 7 M Profiles : a. Apalachicola, 22 Nov 78, 2200Z; b. Apalachicola, 23 Nov 78, 0900Z; c. Apalachicola, 23 Nov 78, 1000Z.

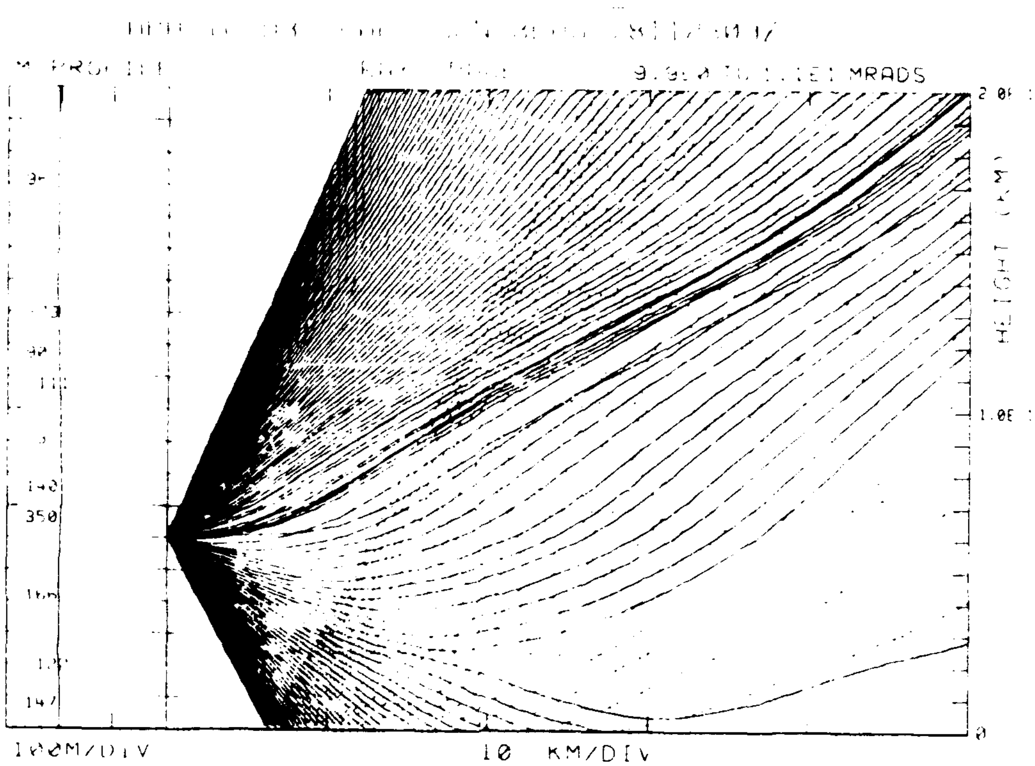


Figure 7-7. Case 7 Raytrace, APA to D3, Cape San Blas, 23 Nov 78, 0900Z, Transmitter Height 61.0 m.

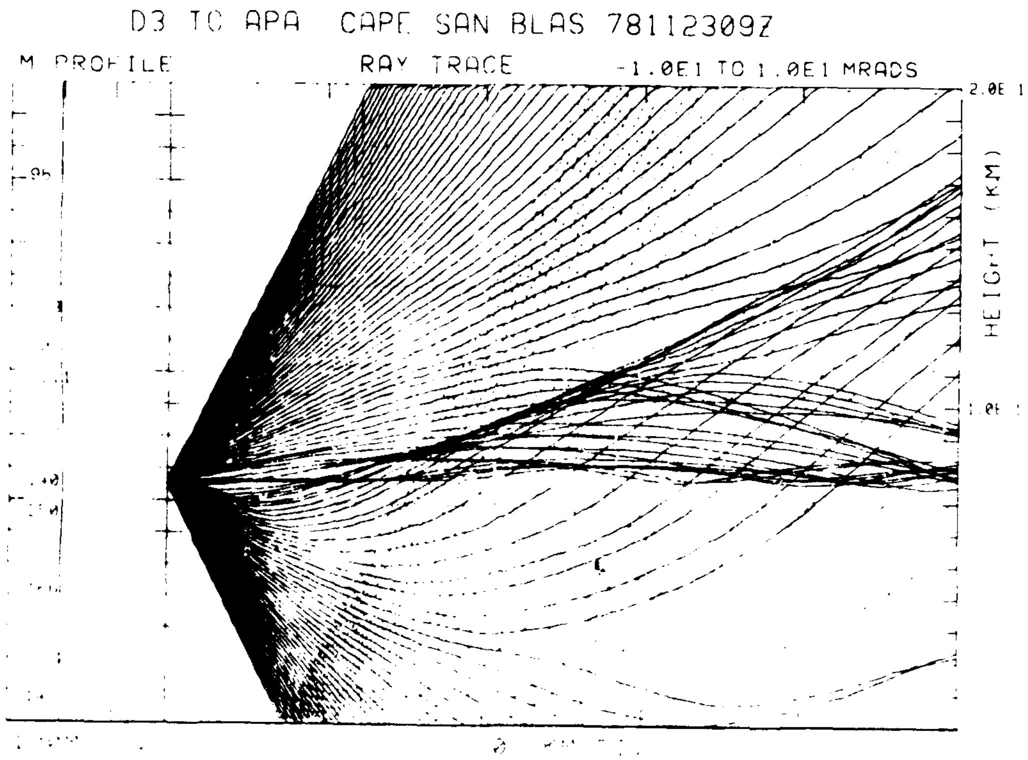


Figure 7-8. Case 7 Raytrace, D3 to APA, Cape San Blas, 23 Nov 78, 0900Z, Transmitter Height 76.2 m.

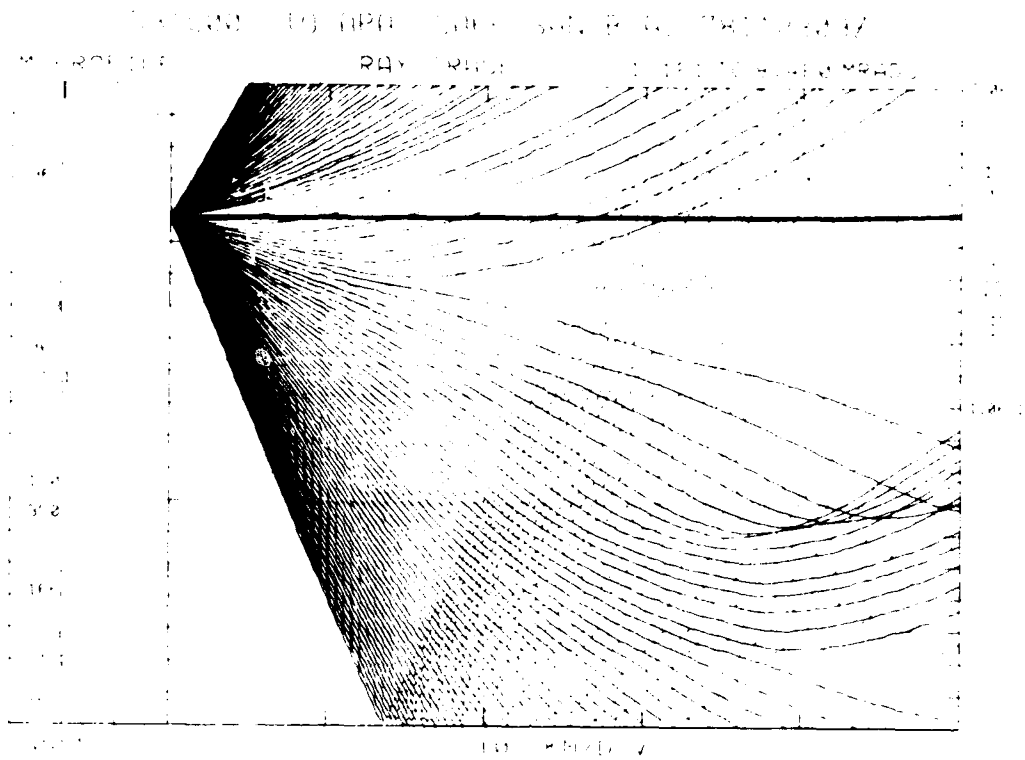


Figure 7-9. Case 7 Raytrace, D3(500) to APA, Cape San Blas 23 Nov 78, 0900Z, Transmitter Height 158.4 m.

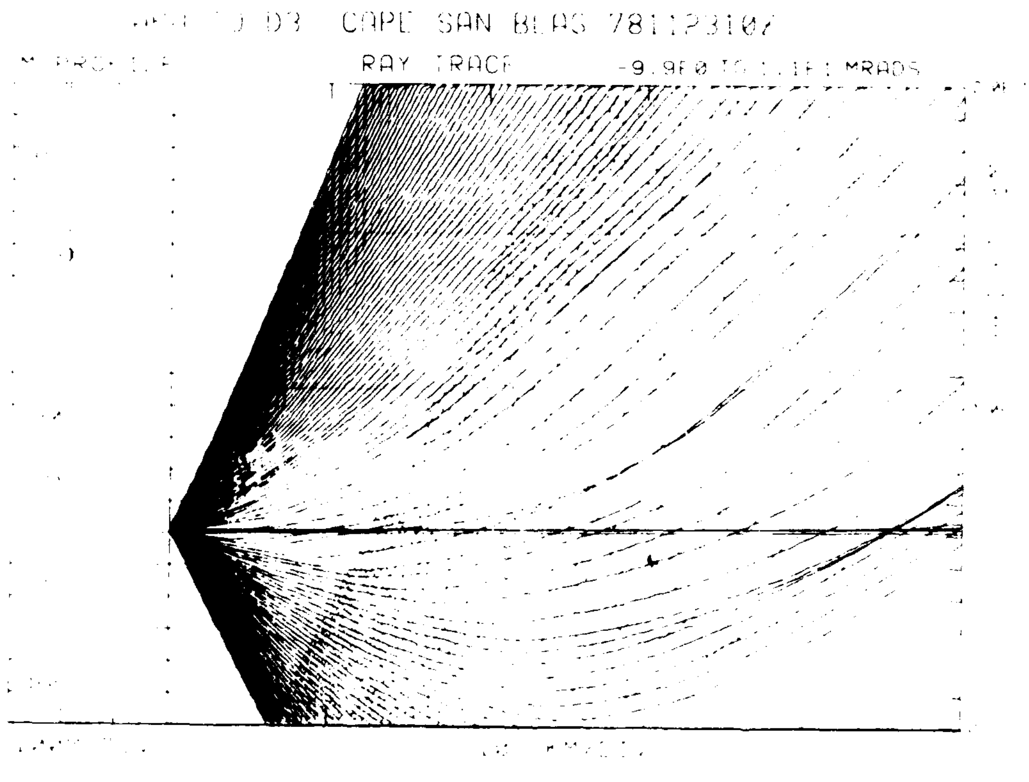


Figure 7-10. Case 7 Raytrace. APA to D3, Cape San Blas, 23 Nov 78, 1000Z, Transmitter Height 61.0 m.

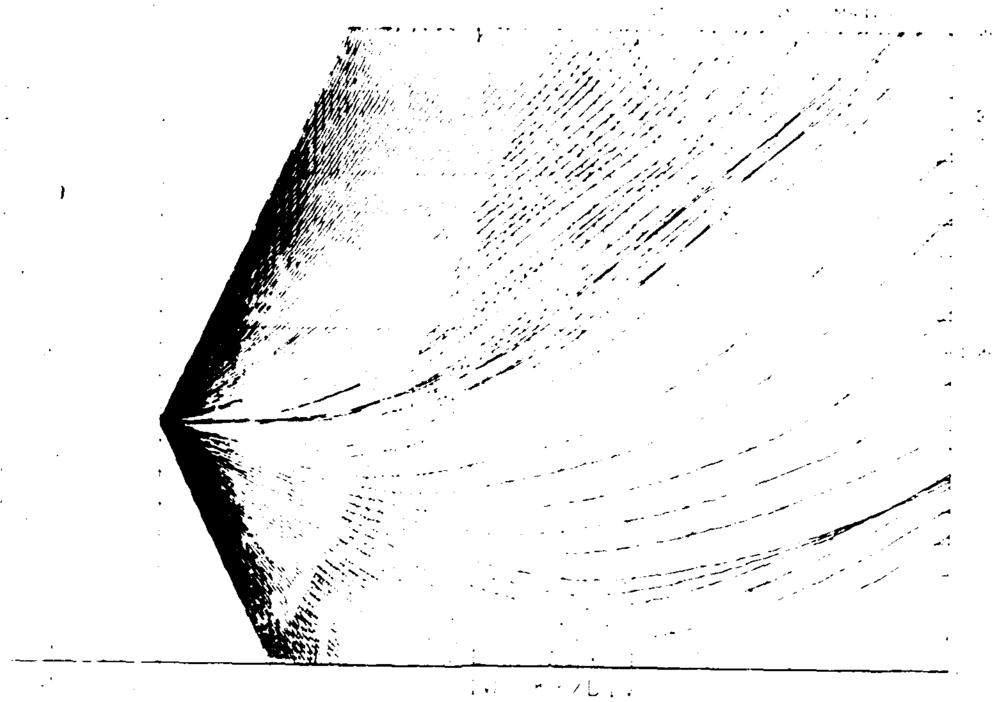


Figure 7-11 . Case 7 Raytrace, D3 to APA, Cape San Blas, 23 Nov 78, 1000Z, Transmitter Height 76.2 m.

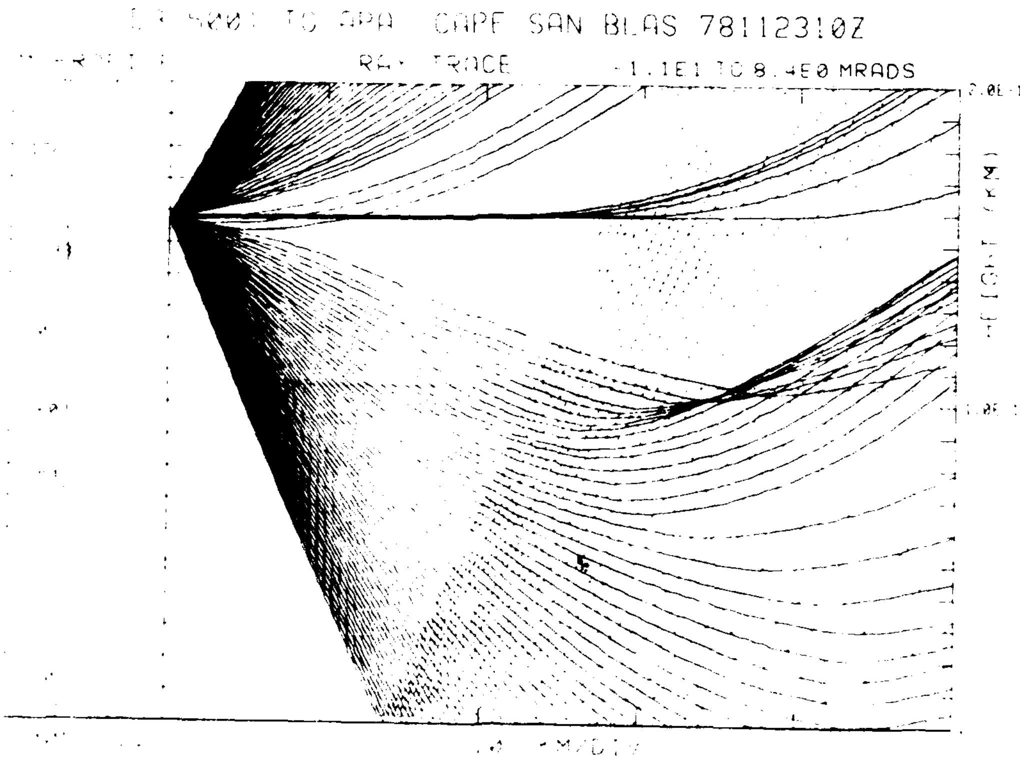


Figure 7-12 . Case 7 Raytrace, D3(500) to APA, Cape San Blas 23 Nov 78, 1000Z, Transmitter Height 158.4 m.

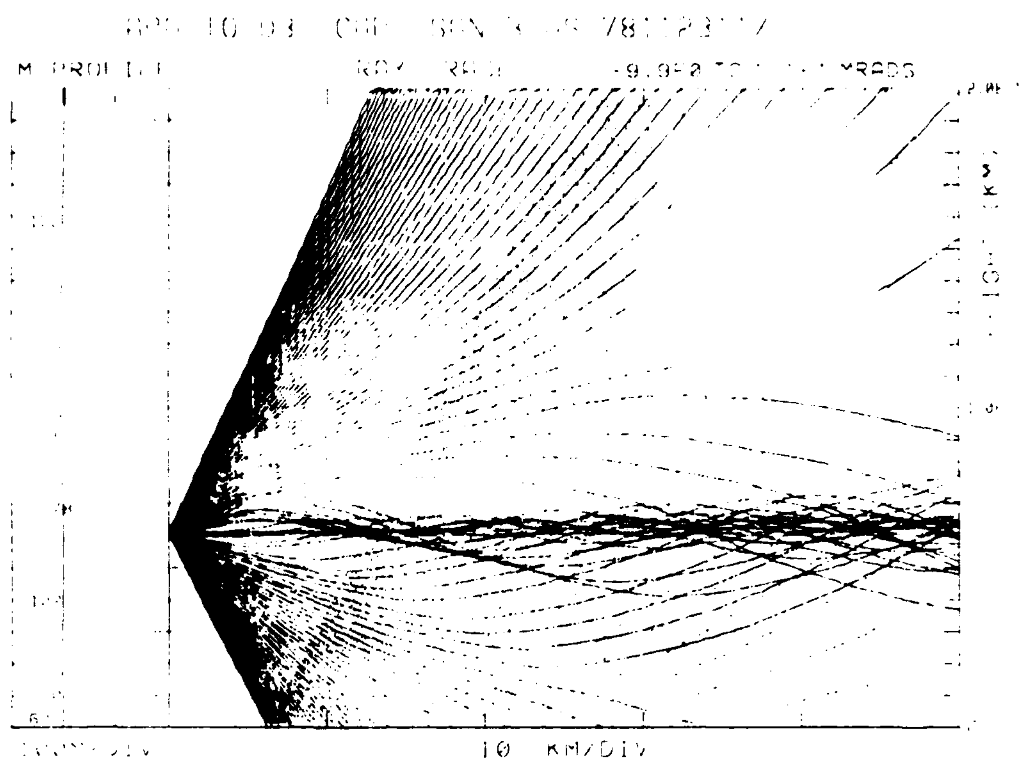


Figure 7-13. Case 7 Raytrace, APA to D3, Cape San Blas, 23 Nov 78, 1100Z, Transmitter Height 61.0 m.

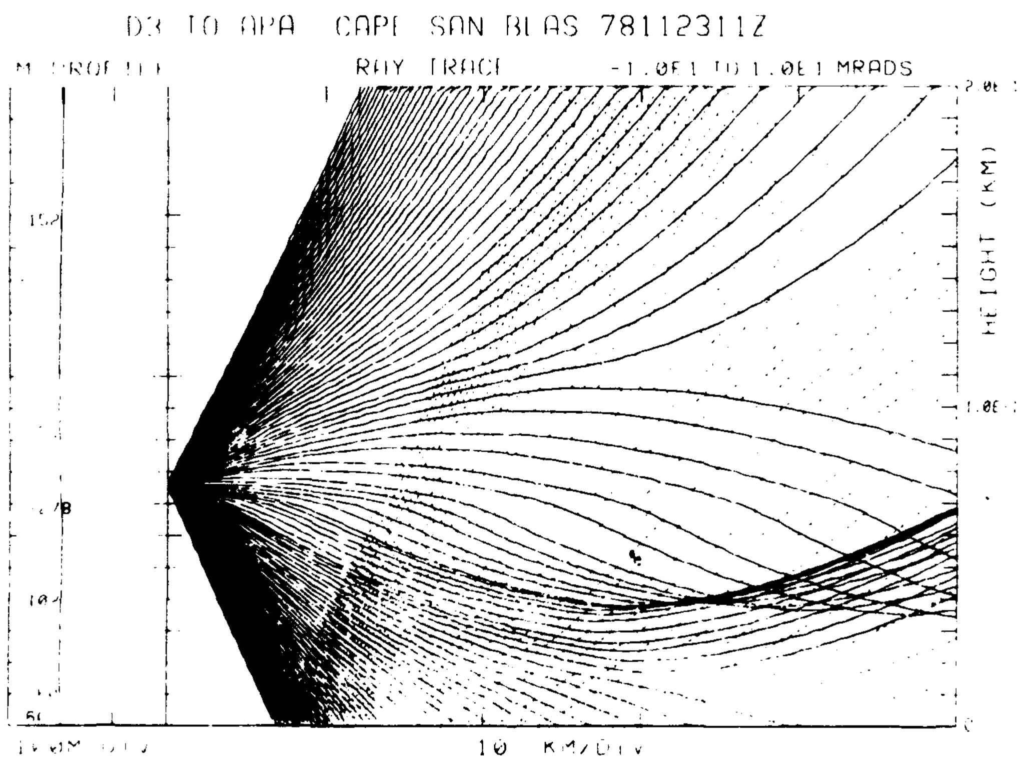


Figure 7-14. Case 7 Raytrace, D3 to APA, Cape San Blas, 23 Nov 78, 1100Z, Transmitter Height 76.2 m.

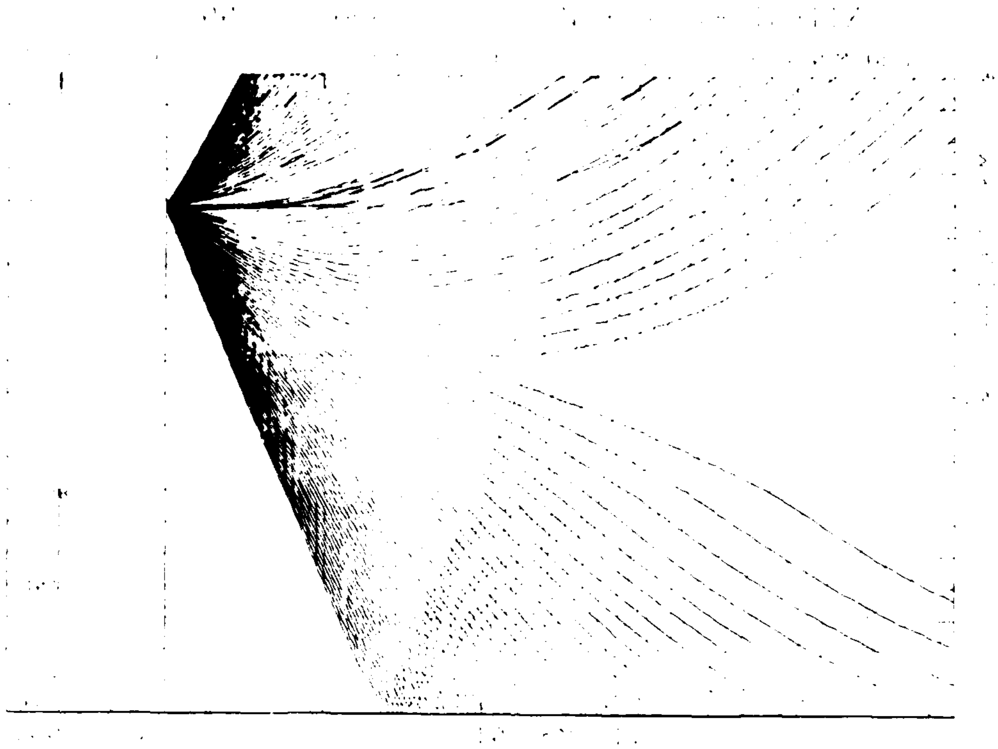


Figure 7-15. Case 7 Raytrace, D3(500) to APA, Cape San Blas 23 Nov 78, 1100Z, Transmitter Height 158.4 m.

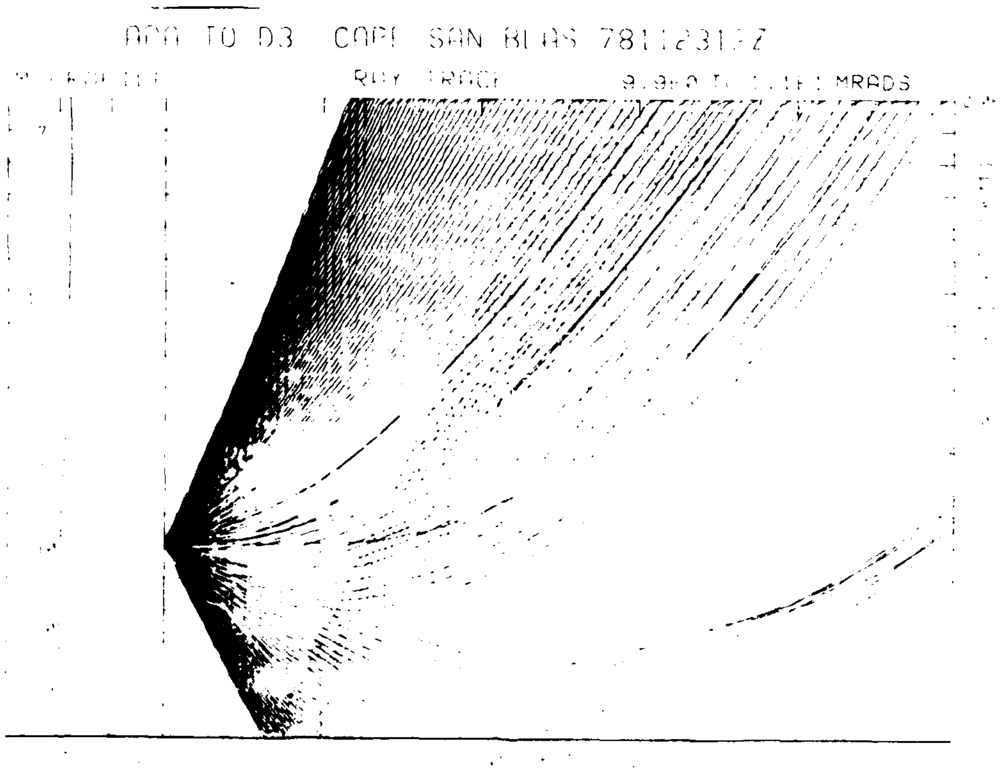


Figure 7-16. Case 7 Raytrace, APA to D3, Cape San Blas, 23 Nov 78, 1200Z, Transmitter Height 61.0 m.

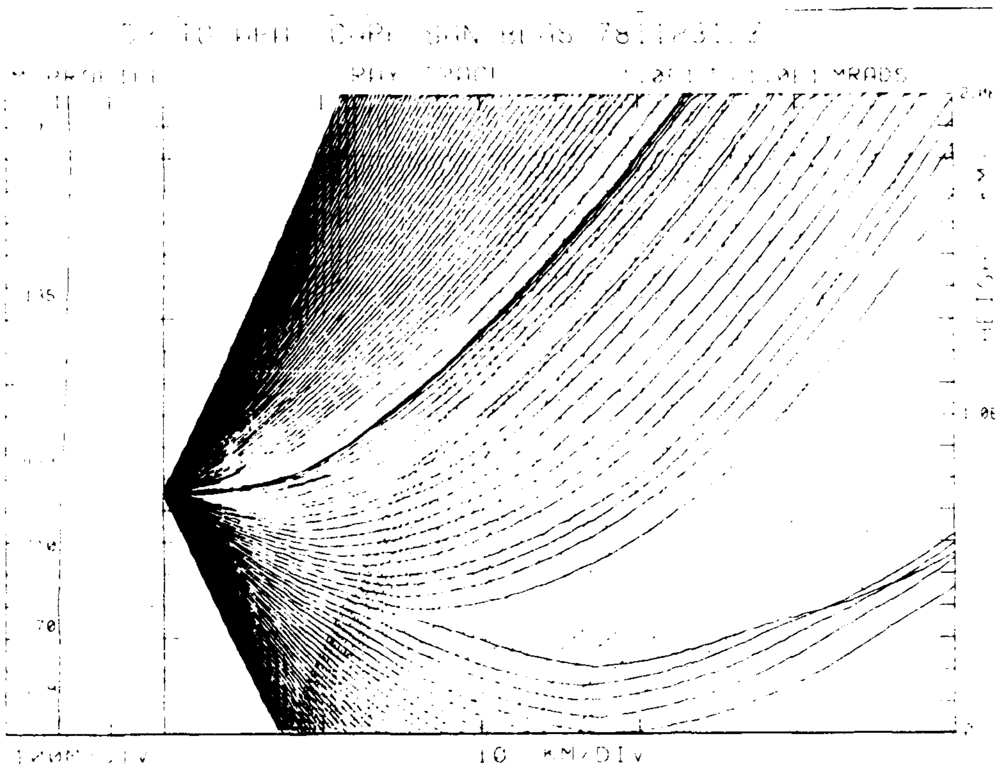


Figure 7-17. Case 7 Raytrace, D3 to APA, Cape San Blas, 23 Nov 78, 1200Z, Transmitter Height 76.2 m.

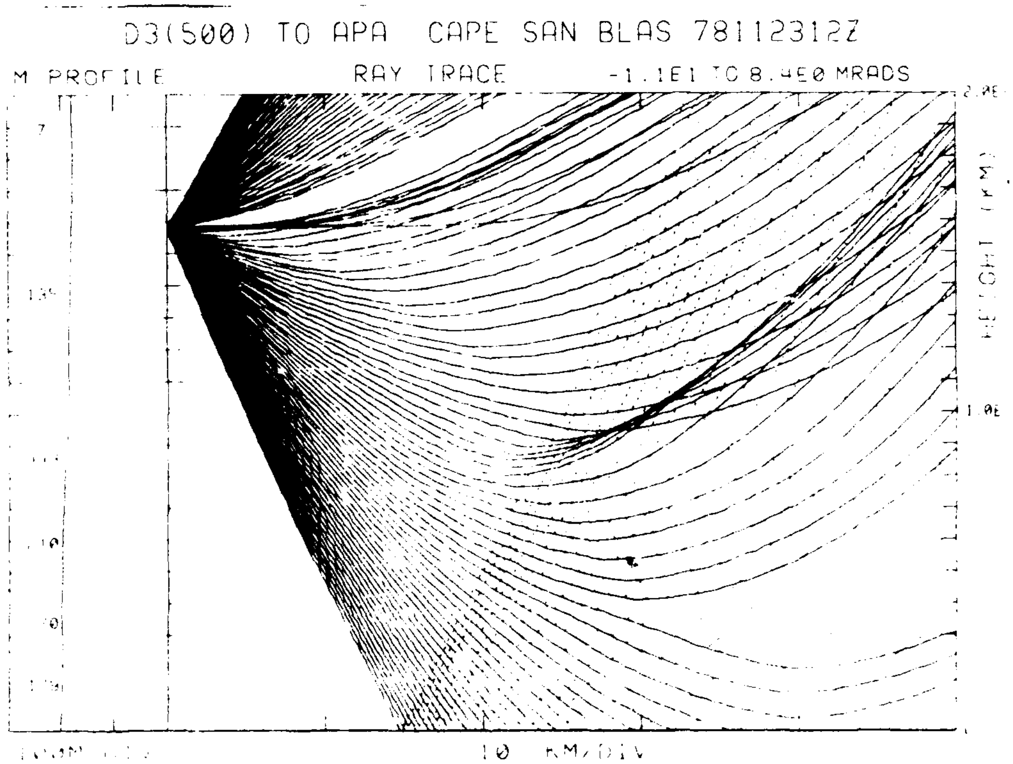


Figure 7-18. Case 7 Raytrace, D3(500) to APA, Cape San Blas 23 Nov 78, 1200Z, Transmitter Height 158.4 m.

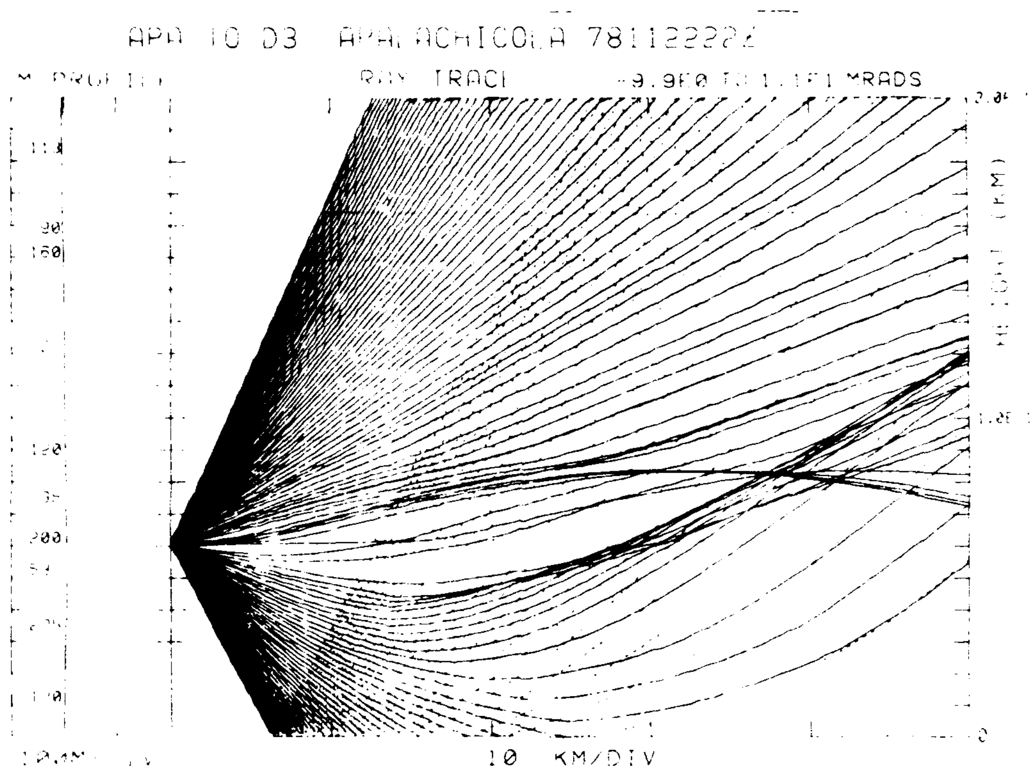


Figure 7-19. Case 7 Raytrace, APA to D3, Apalachicola, 22 Nov 78, 2200Z, Transmitter Height 61.0 m.

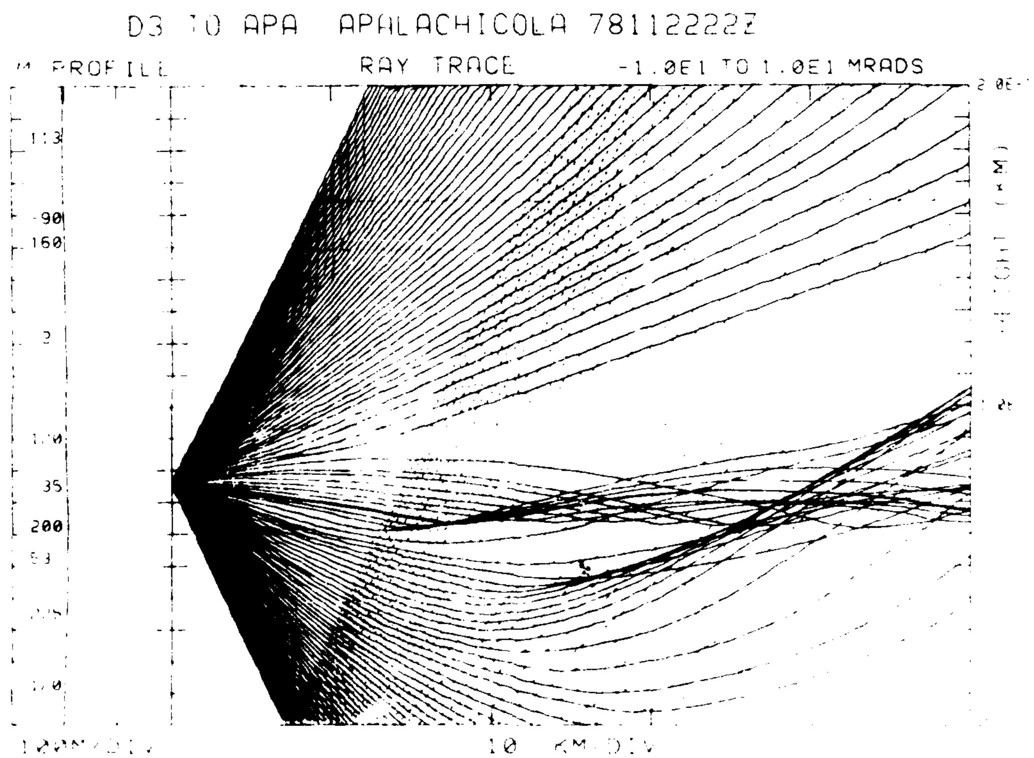


Figure 7-20. Case 7 Raytrace, D3 to APA, Apalachicola, 22 Nov 78, 2200Z, Transmitter Height 76.2 m.

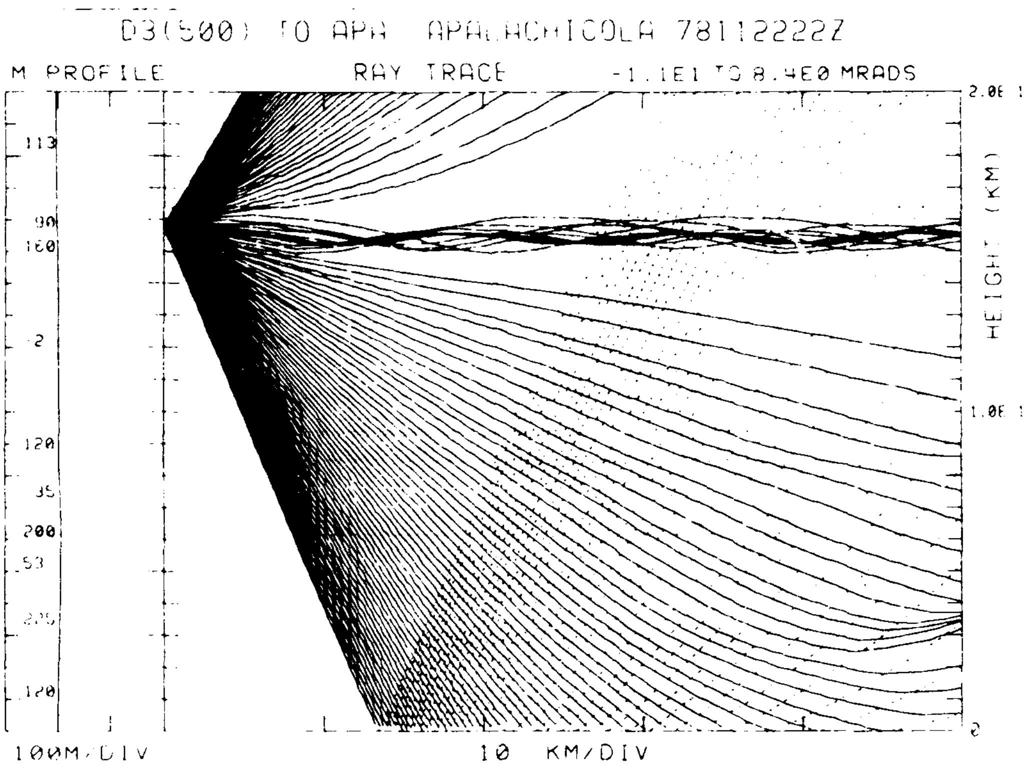


Figure 7-21. Case 7 Raytrace, D3(500) to APA, Apalachicola 22 Nov 78, 2200Z, Transmitter Height 158.4 m.

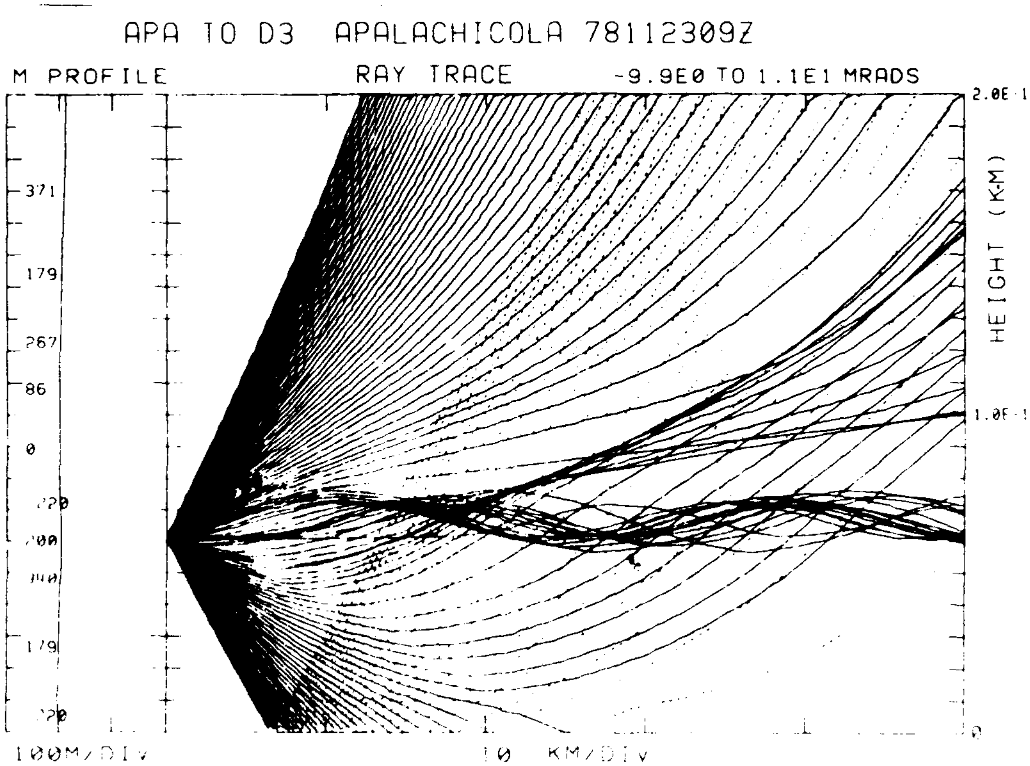


Figure 7-22. Case 7 Raytrace, APA to D3, Apalachicola, 23 Nov 78, 0900Z, Transmitter Height 61.0 m.

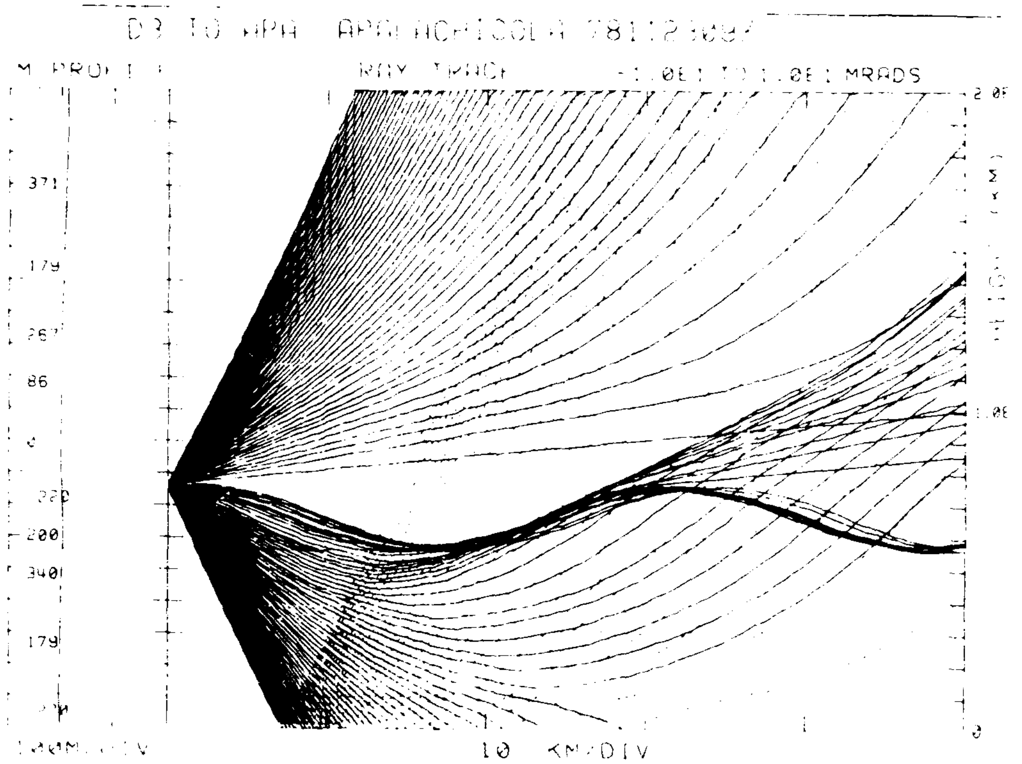


Figure 7-23 . Case 7 Raytrace, D3 to APA, Apalachicola, 23 Nov 78, 0900Z, Transmitter Height 76.2 m.

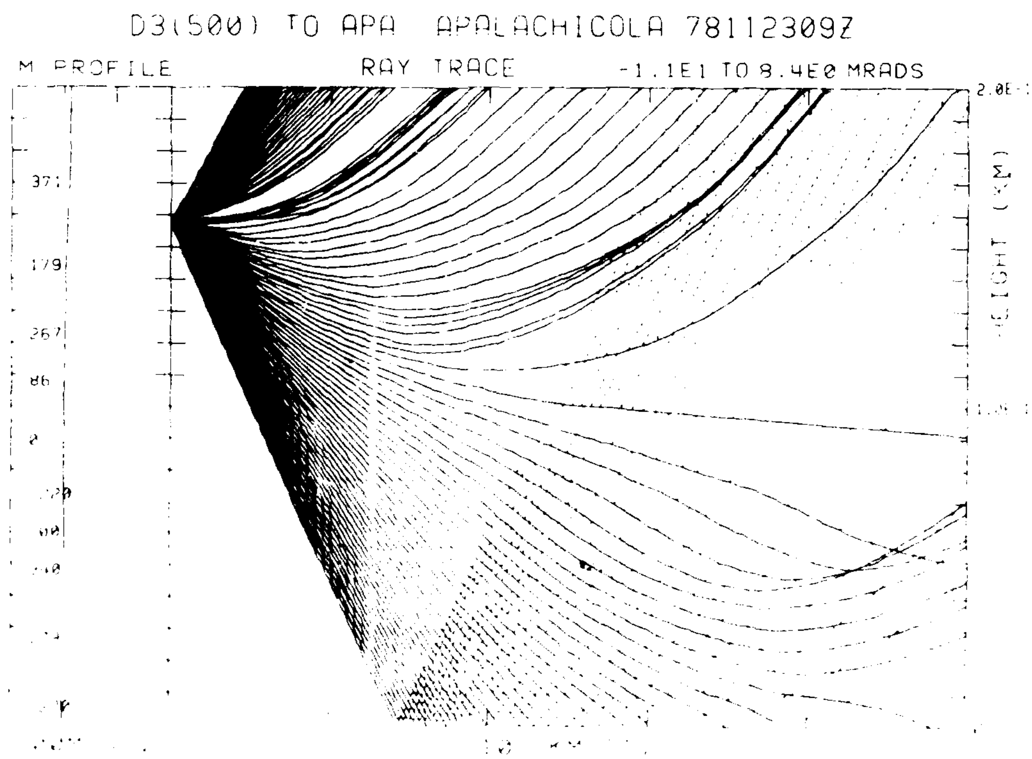


Figure 7-24. Case 7 Raytrace, D3(500) to APA, Apalachicola 23 Nov 78, 0900Z, Transmitter Height 158.4 m.

CASE 8

1. Case 8 (31 Oct/00-20Z) is the first of four declared "good" from an RSL standpoint by the 1842 EEG. It is based on recorded RSL data at D3 as received from D1C. Figures 8-1 and 8-2 depict typical RSL recordings for the period.

2. Figures 8-3 through 8-5 show the synoptic weather pattern for the period. As in previous "bad" cases, the synoptic pattern indicates a relatively weak pressure gradient and lack of any frontal activity. However, the Apalachicola weather radar indicated some isolated rainshowers in the Gulf of Mexico at 15Z. This phenomenon was not indicated in the bad cases. Perhaps this localized convective activity represents a diminished level or absence of subsidence (downward vertical motion of the synoptic air) that usually creates low-level temperature inversions during the early morning. Examination of the MWS Apalachicola rawinsonde temperature and dew-point temperature vertical profiles for the period did, in fact, indicate little or no subsidence or strong surface-based temperature inversions (temperature increases with height).

3. Tables 8-1 through 8-3 indicate similar surface weather conditions to those observed during the "bad" cases, except that wind speeds were somewhat stronger (about 10 knots) and there was an increase in clouds near the middle of the period.

4. Figure 8-6 depicts the two M-profiles from Cape San Blas that were available for this period. A surface-based duct extended to about 30 meters at 00Z, whereas the 16Z profile displayed only smaller scale M variability up through 150 meters.

5. Raytraces of the two M-profiles are shown in Figures 8-7 through 8-12. The 158.4-meter antenna height was represented, in spite of this being a "good" case, just to see if improvement in ray patterns would still occur. However, little can be said about the raytraces because only two M-profiles, spaced 16 hours apart, were available.

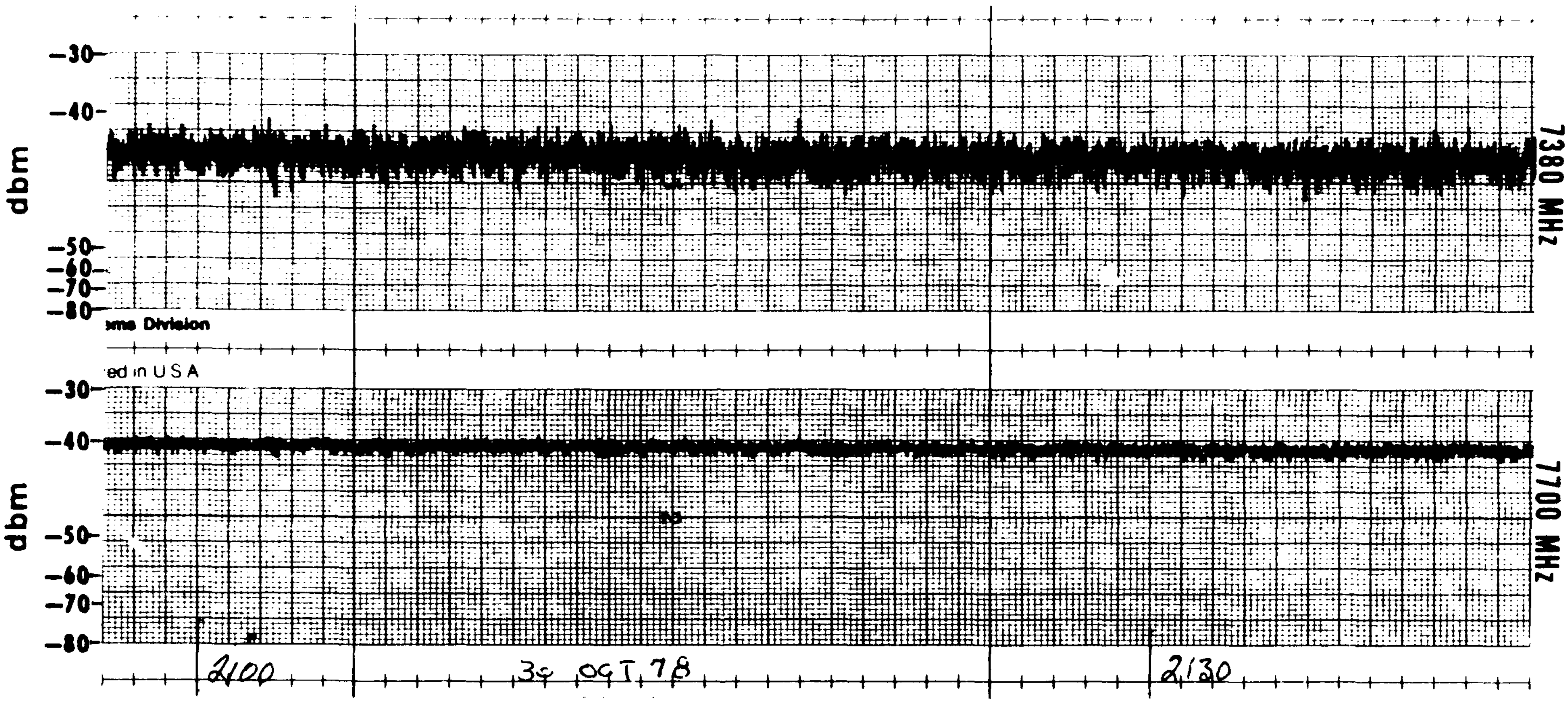


Figure 8-1 Case 8 RSL Strip Chart showing typical stable pattern on both channels of D1C received from D3. Times are from 2057 CST to 2142 CST, 30 Oct 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

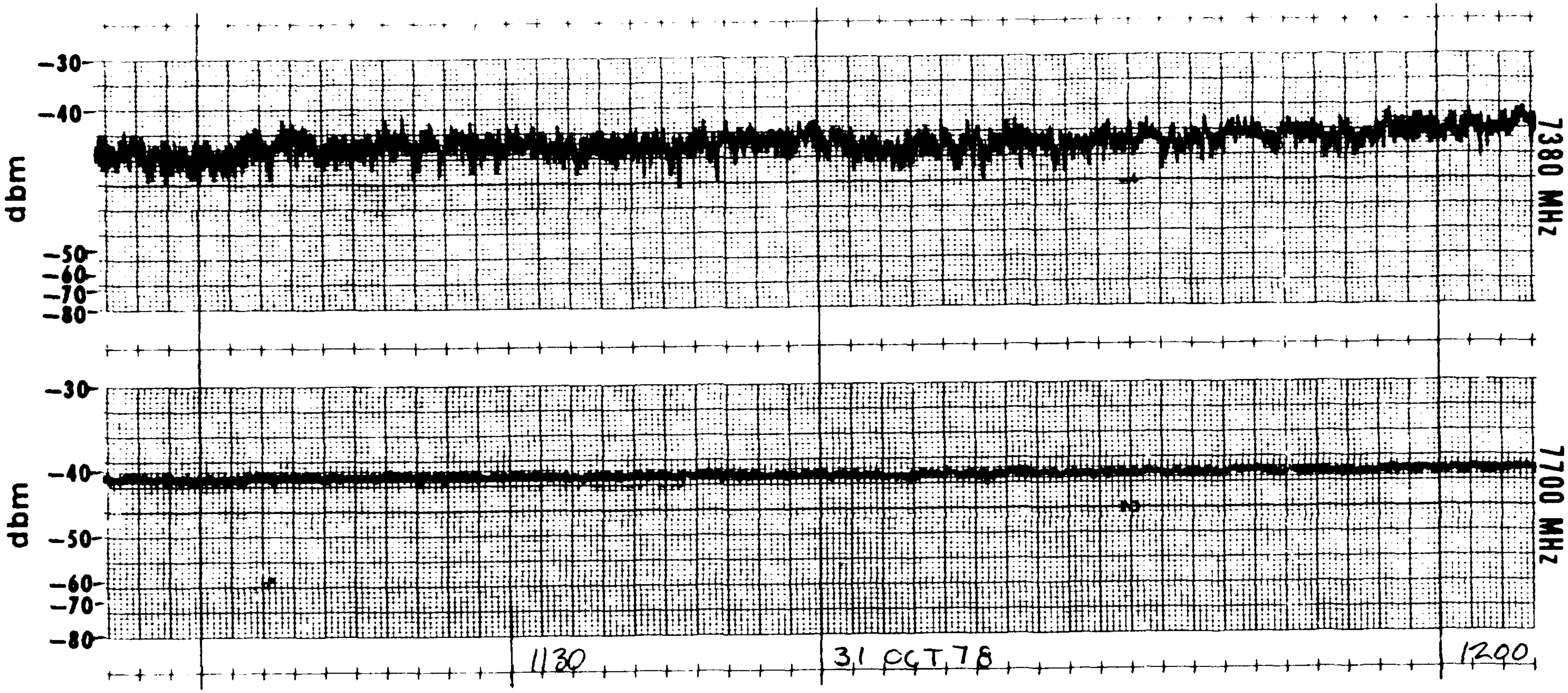


Figure 8-2 ***Case 8 RSL Strip Chart*** *showing typical stable pattern on both channels of DIC* received from D3. Times are from 1117 CST to 1203 CST, 31 Oct 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

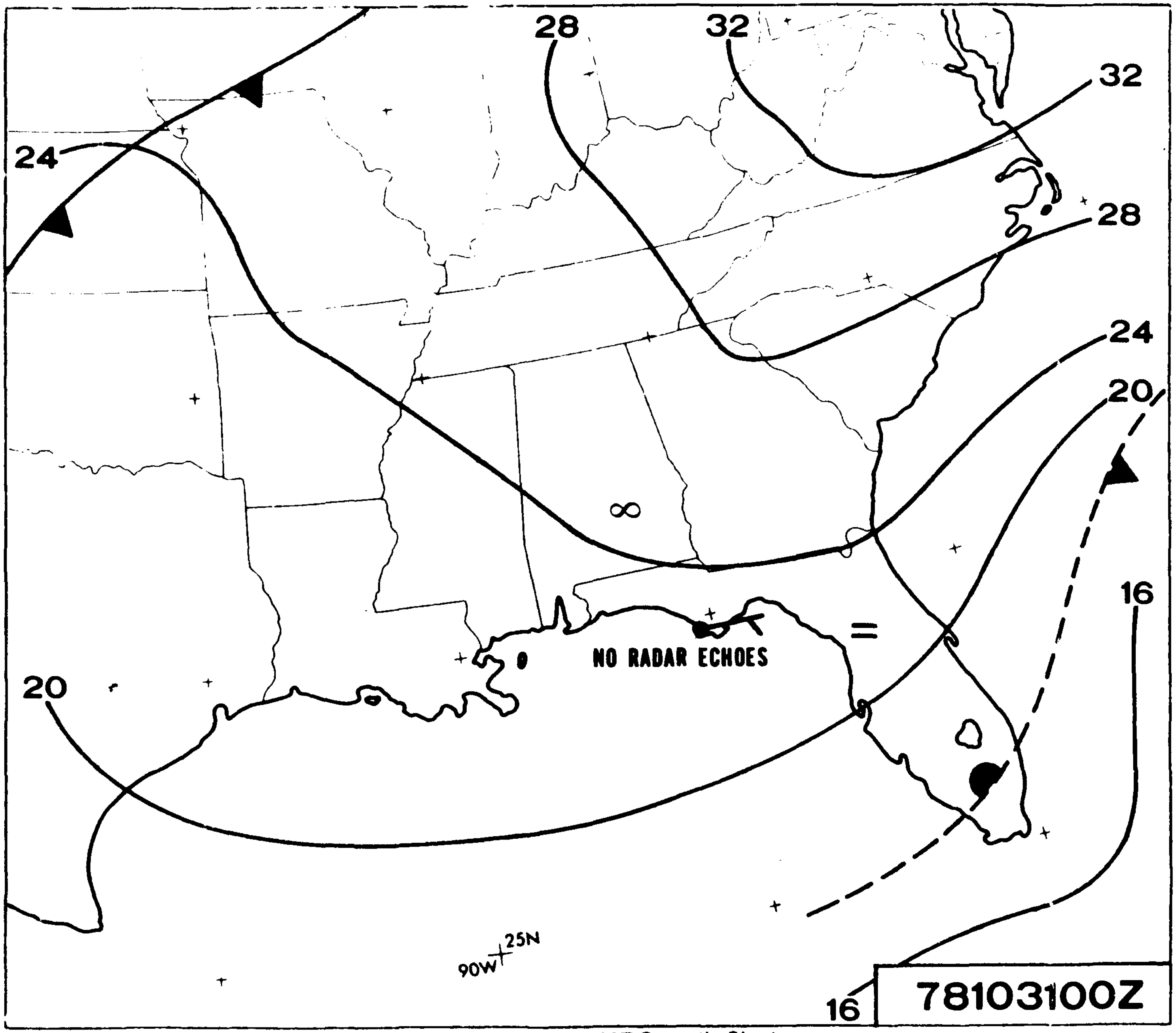


Figure 8-3 78103100Z Synoptic Chart

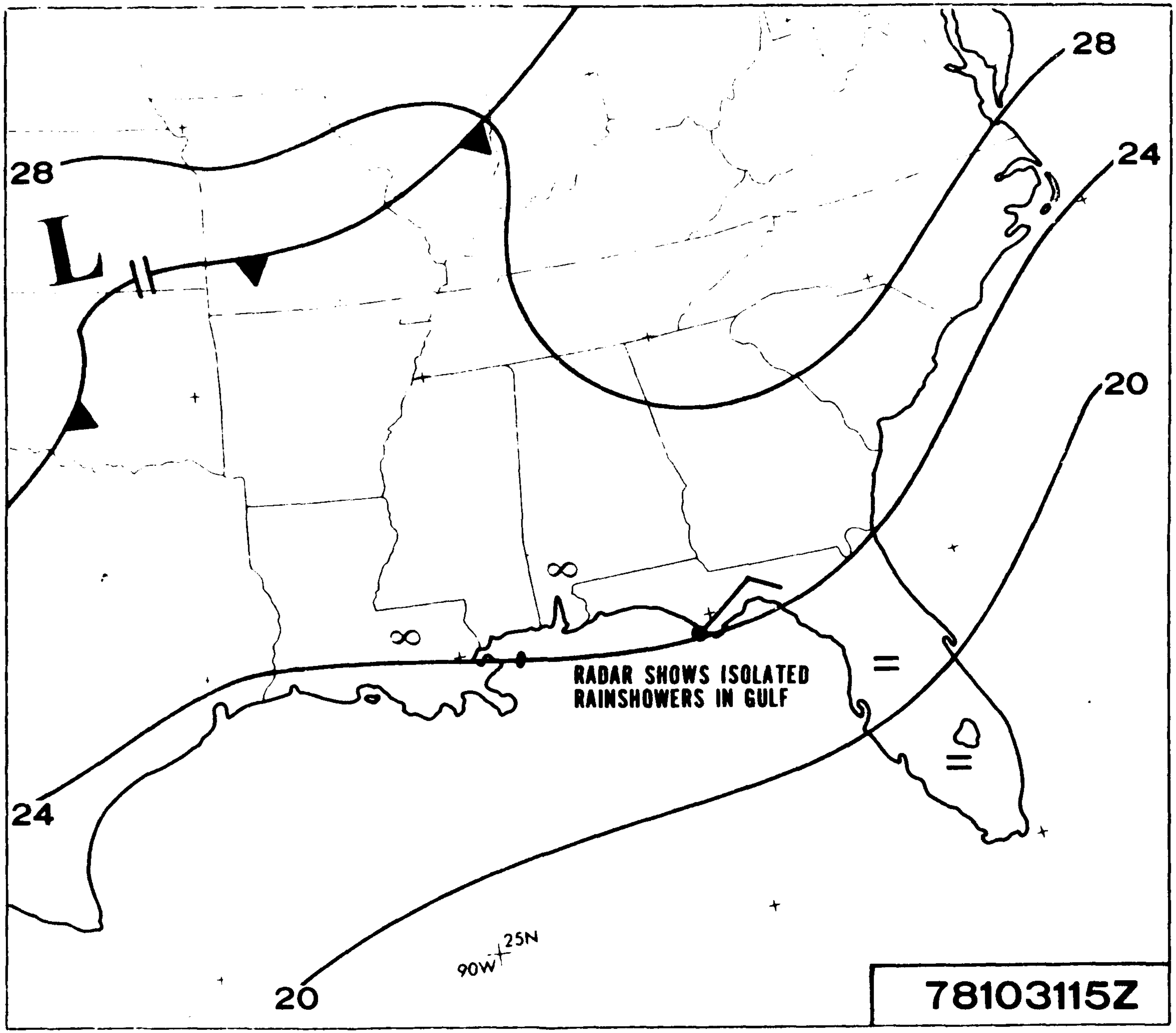


Figure 8-4 78103115Z Synoptic Chart

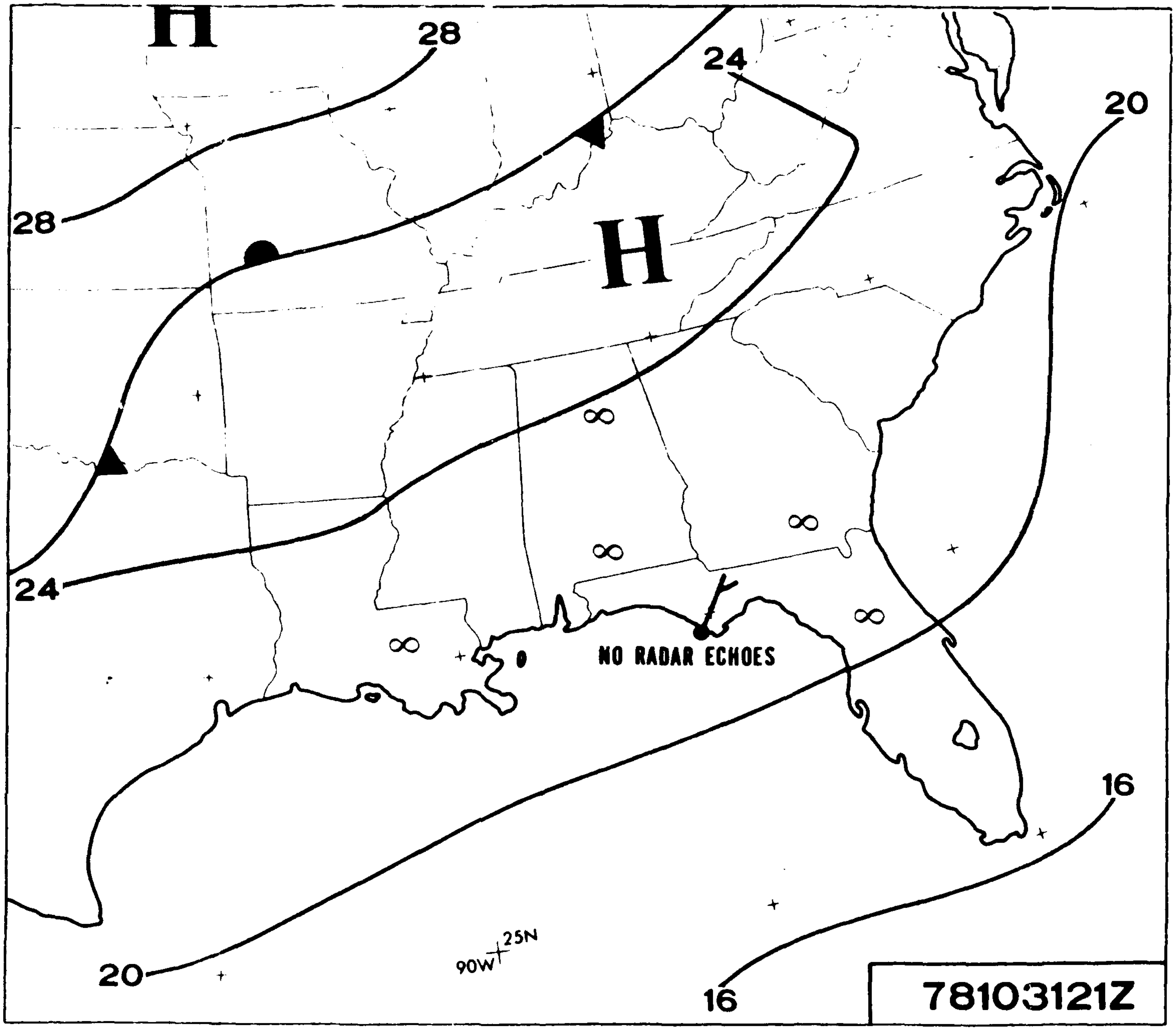


Figure 8-5 78103121Z Synoptic Chart

Table 8-1. Case 8, Apalachicola Surface Weather, 31 Oct 78, 0000Z - 31 Oct 78, 2000Z.

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
10 31 00	22.2	4.4	100	8	SCT	7	None
06	19.4	3.3	80	11	SCT	--	None
09	17.8	3.4	60	7	SCT	7	None
12	17.8	5.0	60	9	BKN	7	None
15	20.6	8.4	70	13	BKN	6	H
18	24.4	8.8	70	10	SCT	7	None
21	24.4	7.2	160	6	CLR	7	None

Table 8-2. Case 8, Tyndall Surface Weather, 31 Oct 78, 0000Z - 31 Oct 78, 2000Z.

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
10 31 00	22.2	6.6	90	3	SCT	7	None
03	20.6	5.6	50	4	SCT	7	None
06	20.0	5.6	60	6	BKN	7	None
09	18.9	5.6	50	8	CLR	7	None
12	18.9	7.8	50	9	OVC	7	None
15	22.2	11.1	30	10	BKN	7	None
18	25.0	11.7	20	6	BKN	7	None
21	26.7	12.8	10	7	BKN	7	None

Table 8-3. Case 8, Eglin Surface Weather, 31 Oct 78, 0000Z - 31 Oct 78, 2000Z.

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
10 31 00	24.4	8.8	360	2	SCT	7	None
03	22.2	7.8	50	5	CLR	14	None
06	20.0	5.6	40	4	CLR	14	None
09	18.3	2.7	20	4	CLR	14	None
12	17.8	3.9	10	2	SCT	6	F
15	22.2	9.4	50	8	SCT	7	None
18	31.7	16.7	50	7	OVC	8	None
21	27.2	12.2	20	5	BKN	10	None

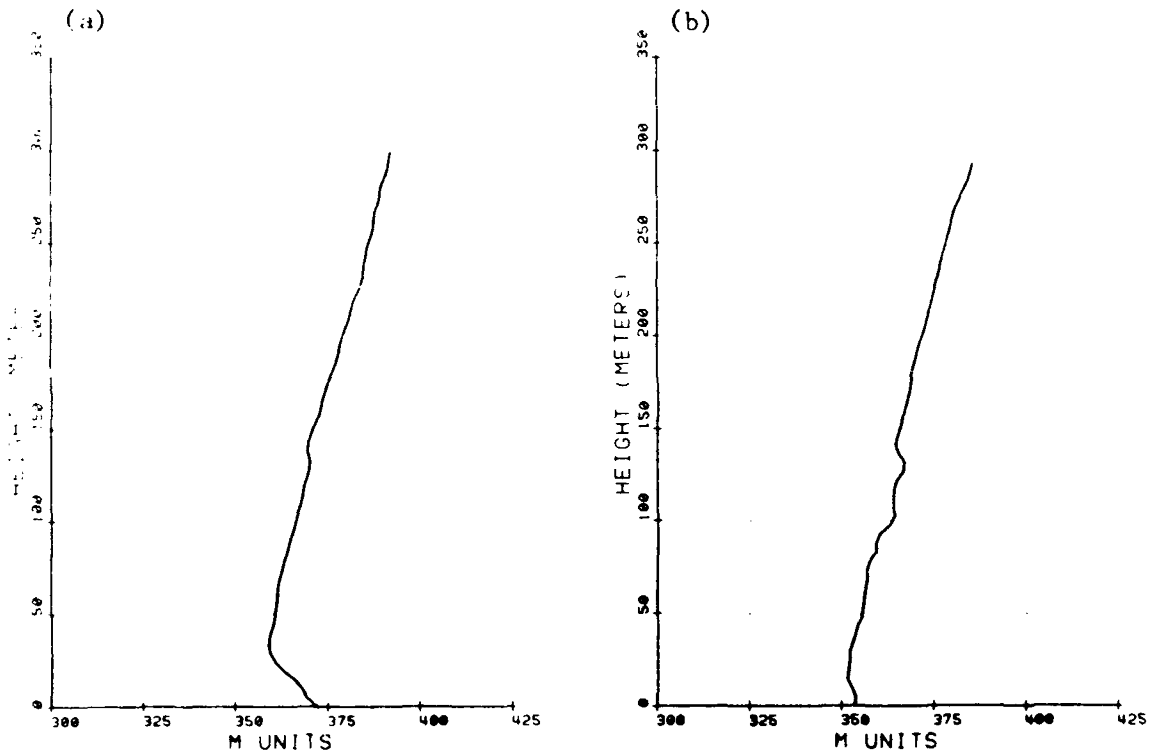


Figure 8-6 Case 8 M-Profiles: a. Cape San Blas, 31 Oct 78, 0000Z; b. Cape San Blas, 31 Oct 78, 1600Z.

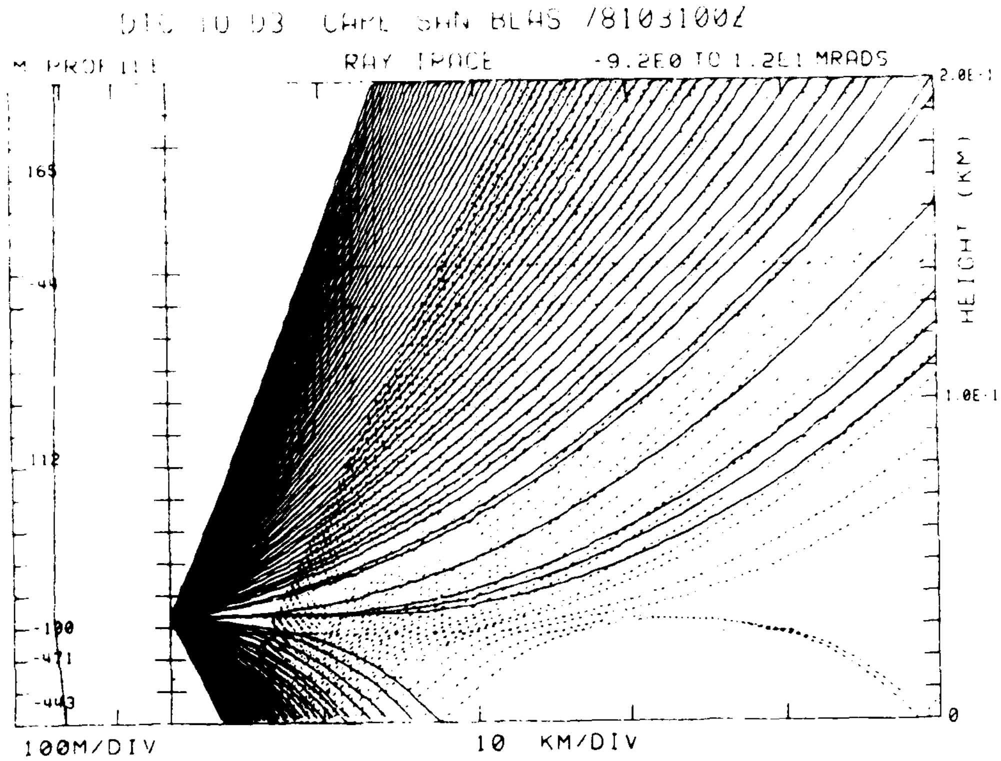


Figure 8-7. Case 8 Raytrace, D1C to D3, Cape San Blas, 31 Oct 78, 0000Z, Transmitter Height 33.5 m.

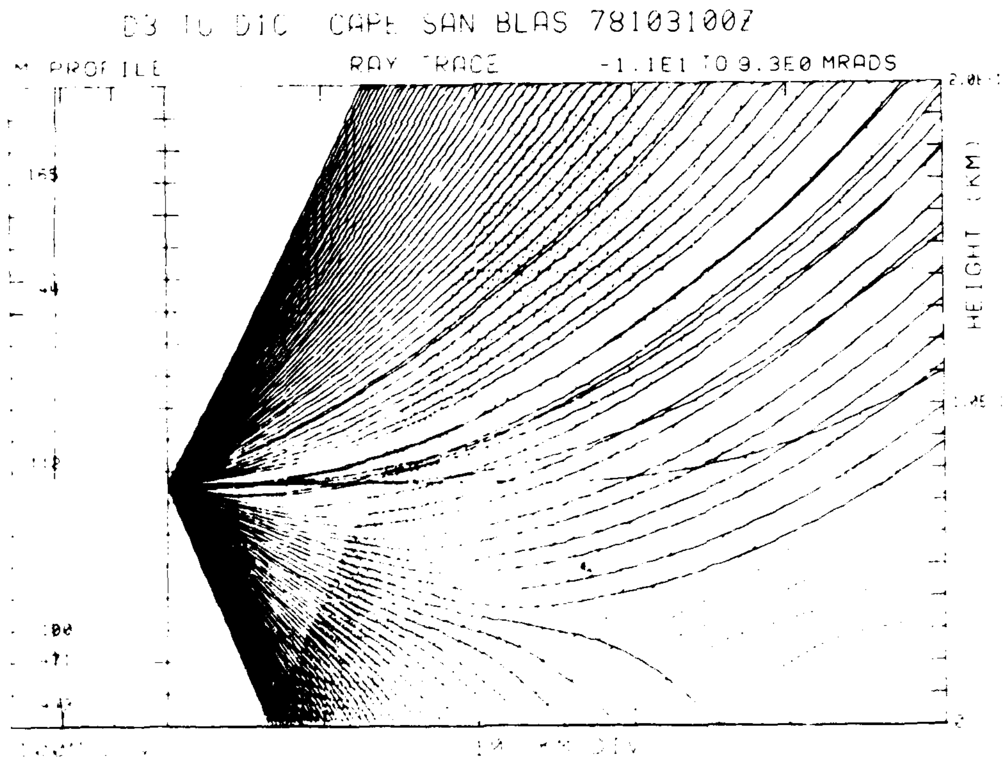


Figure 8-8. Case 8 Raytrace, D3 to D1C, Cape San Blas, 31 Oct 78, 0000Z, Transmitter Height 76.2 m.

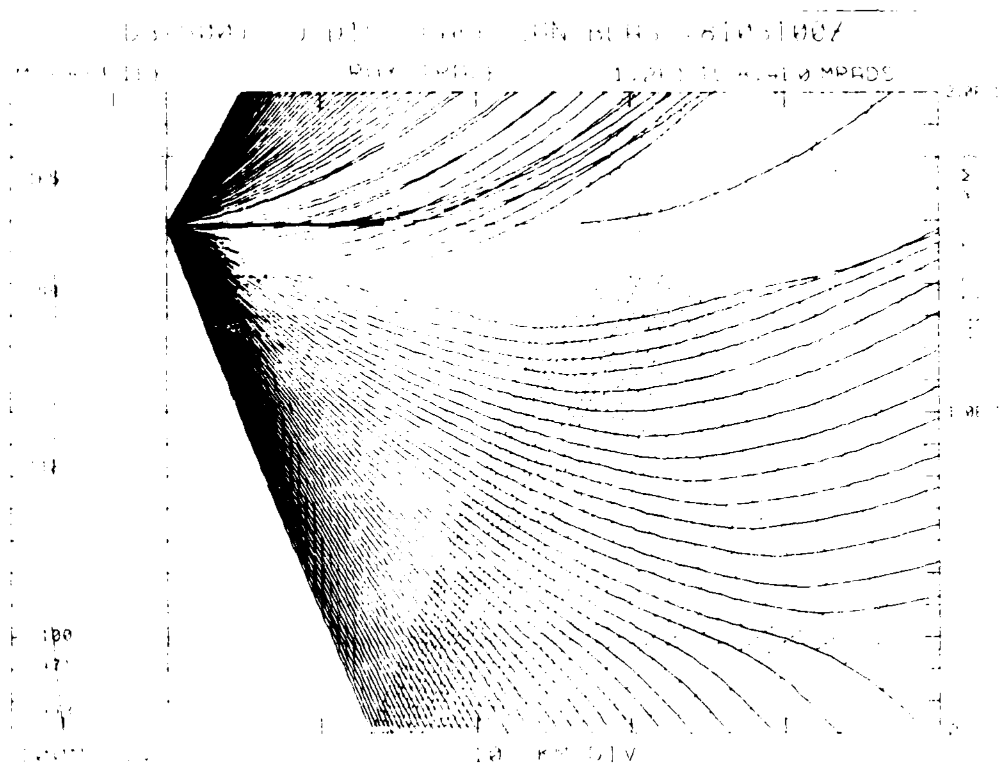


Figure 8-9 . Case 8 Raytrace, D3(500) to D1C, Cape San Blas 31 Oct 78, 0000Z, Transmitter Height 158.4 m.

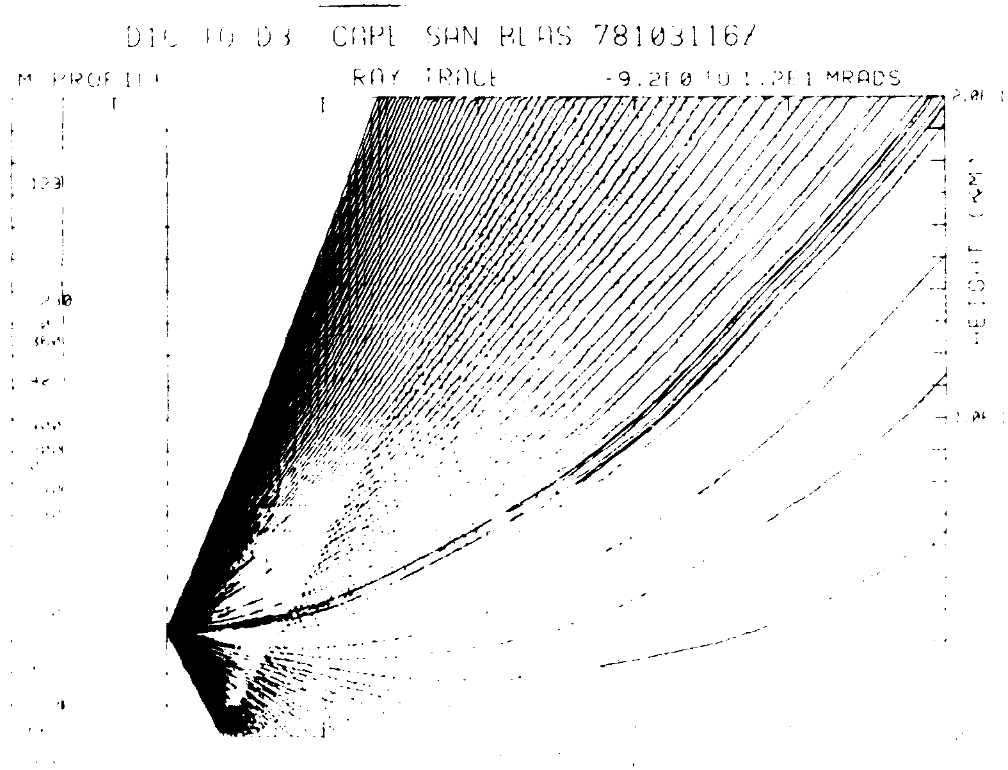


Figure 8-10 . Case 8 Raytrace, D1C to D3, Cape San Blas, 31 Oct 78, 1600Z, Transmitter Height 33.5 m.

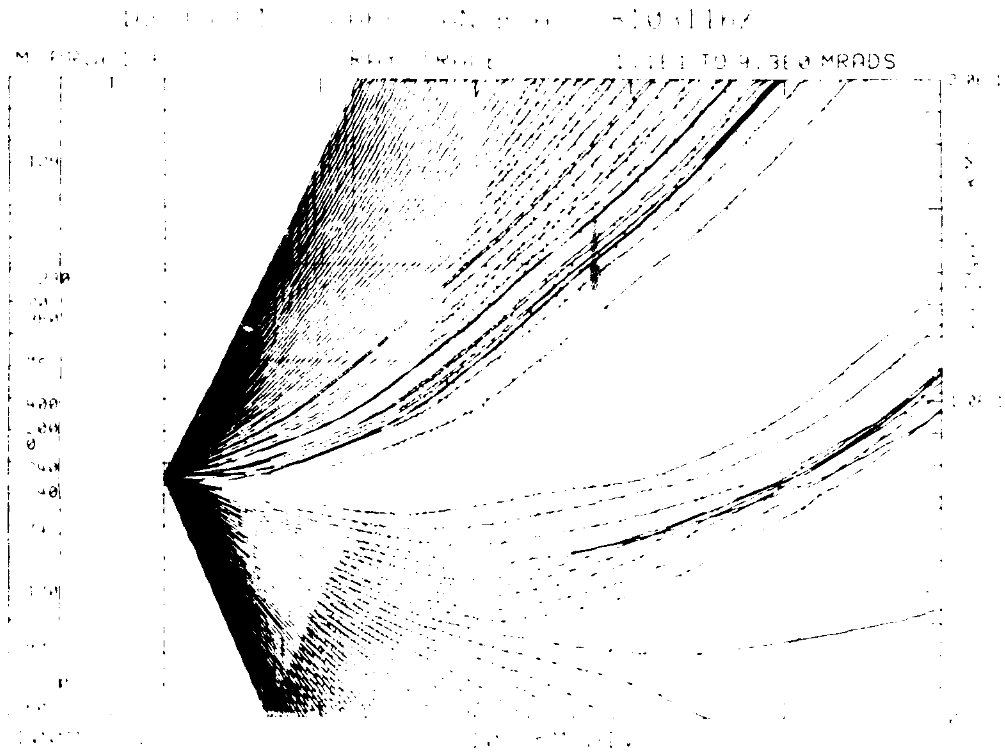


Figure 8-11. Case 8 Raytrace, D3 to DIC, Cape San Blas, 31 Oct 78, 1600Z, Transmitter Height 76.2 m.

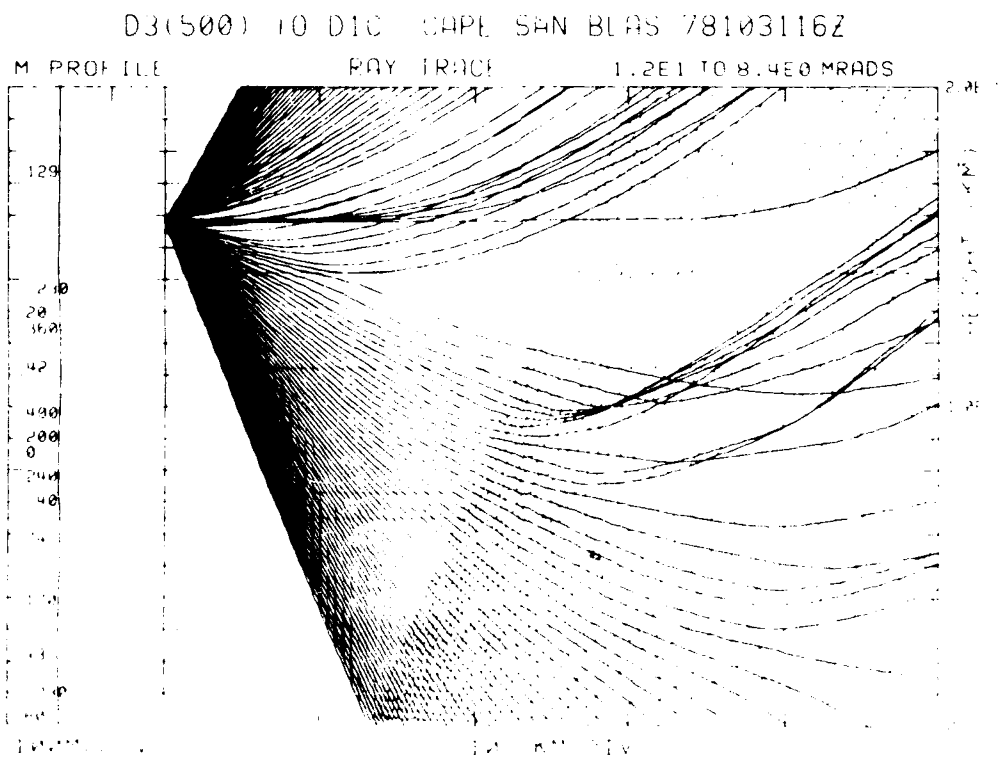


Figure 8-12. Case 8 Raytrace, D3(500) to DIC, Cape San Blas 31 Oct 78, 1600Z, Transmitter Height 158.4 m.

CASE 9

1. Case 9 was a "good" period (6 Nov/11Z-7 Nov/19Z) and is based on RSL data recorded at D3 from D1C. Figures 9-1 and 9-2 show typical RSL patterns for the period.

2. Figures 9-3 through 9-6 show the synoptic weather pattern for the period. Surface winds were more southerly through most of the period until a cold front passed through the area. The southerly winds and the frontal passage undoubtedly contributed to a relatively well-mixed volume of air encompassing the link. This restricted the development of more stable layers of refractive discontinuities; a "good" RSL signal would be therefore be expected.

3. Tables 9-1 through 9-3 clearly indicate the weather conditions associated with a cold frontal passage (windshift from southerly to northwesterly, general cloudiness, precipitation).

4. Figures 9-7 through 9-10 show available M-profiles for the period from all three tethered balloon sites. They show the usual minor fluctuations in M with height; however, no obvious trends appear regarding distinct "breakpoints" or significant ducts. Strong surface-based subrefraction occurred at White City on 7 Nov/08Z.

5. Figures 9-11 through 9-43 illustrate the ray patterns based on the M-profiles of the period. This was the last case in which the 158.4-meter antenna height was used in the raytraces. Strangely enough, general improvement in the direct ray patterns occurred even though the RSL patterns were good. Since many of the raytraces for existing antenna heights showed disrupted ray patterns when the RSL data were good, the utility of raytracing for depicting real propagation conditions warrants careful scrutiny.

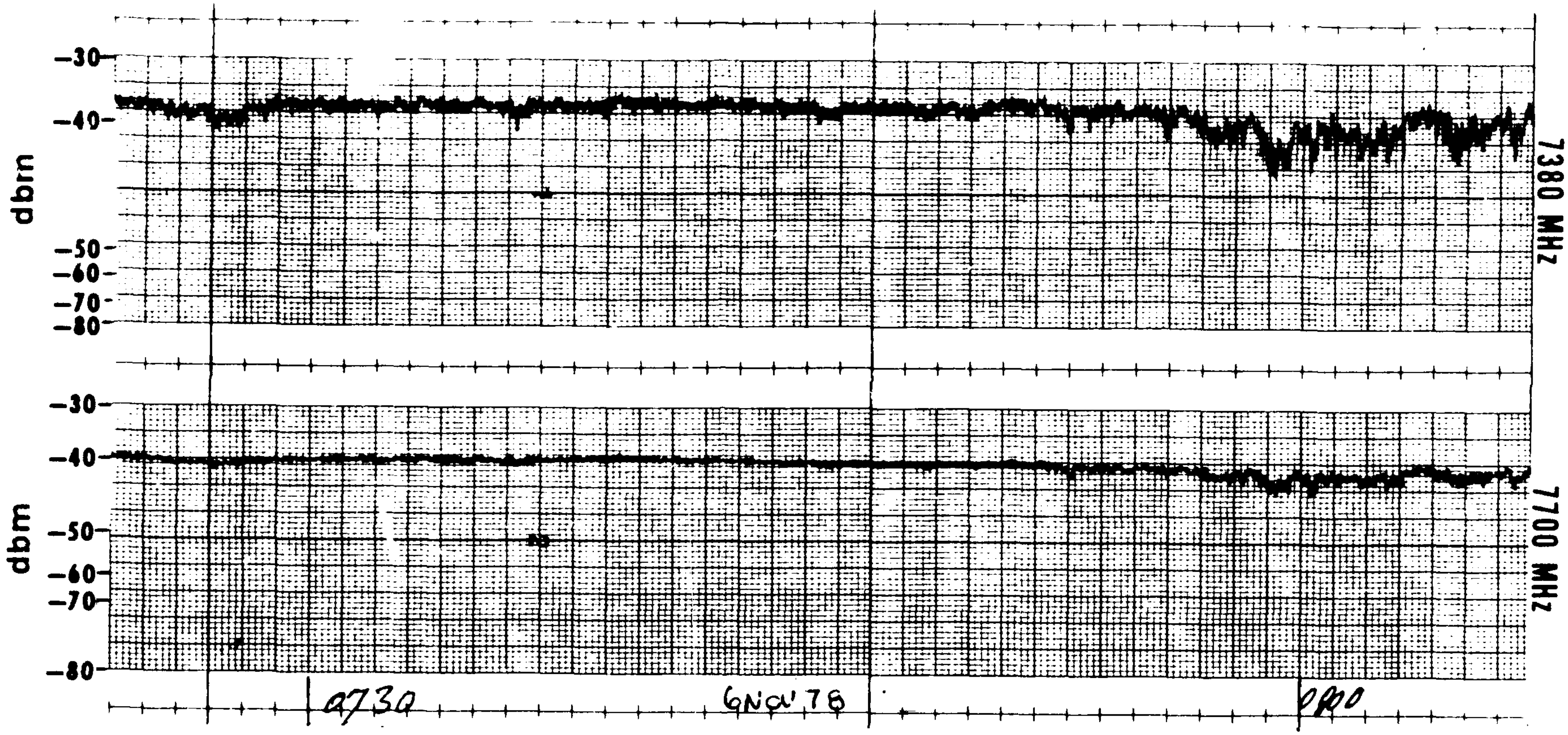


Figure 9-1 Case 9 RSL Strip Chart showing typical stable pattern on both channels of D1C received from D3. Times are from 0724 CST to 0807 CST, 6 Nov 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

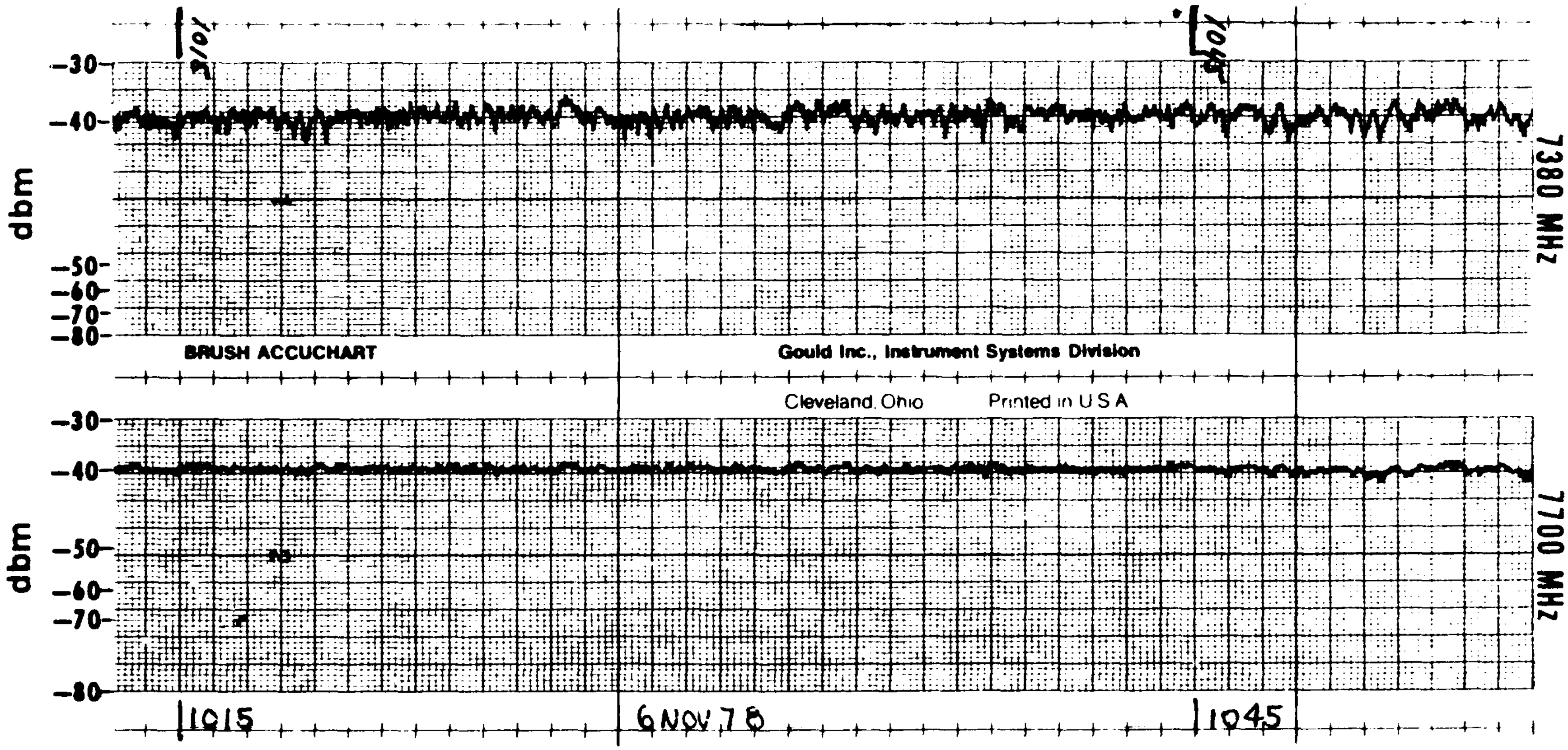


Figure 9-2 Case 9 RSL Strip Chart showing typical stable pattern on both channels of D1C received from D3. Times are from 1013 CST to 1055 CST, 6 Nov 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

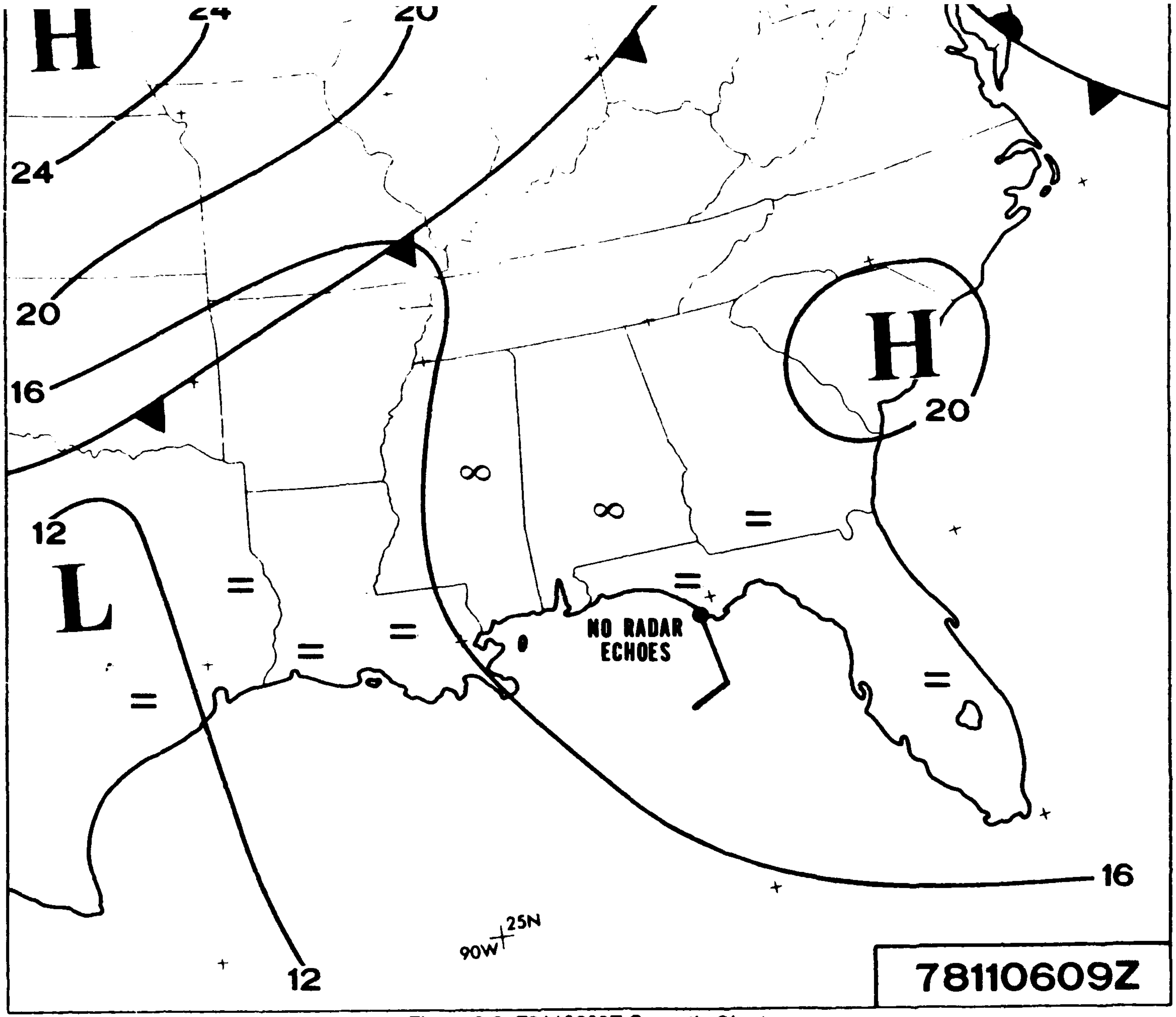


Figure 9-3 78110609Z Synoptic Chart

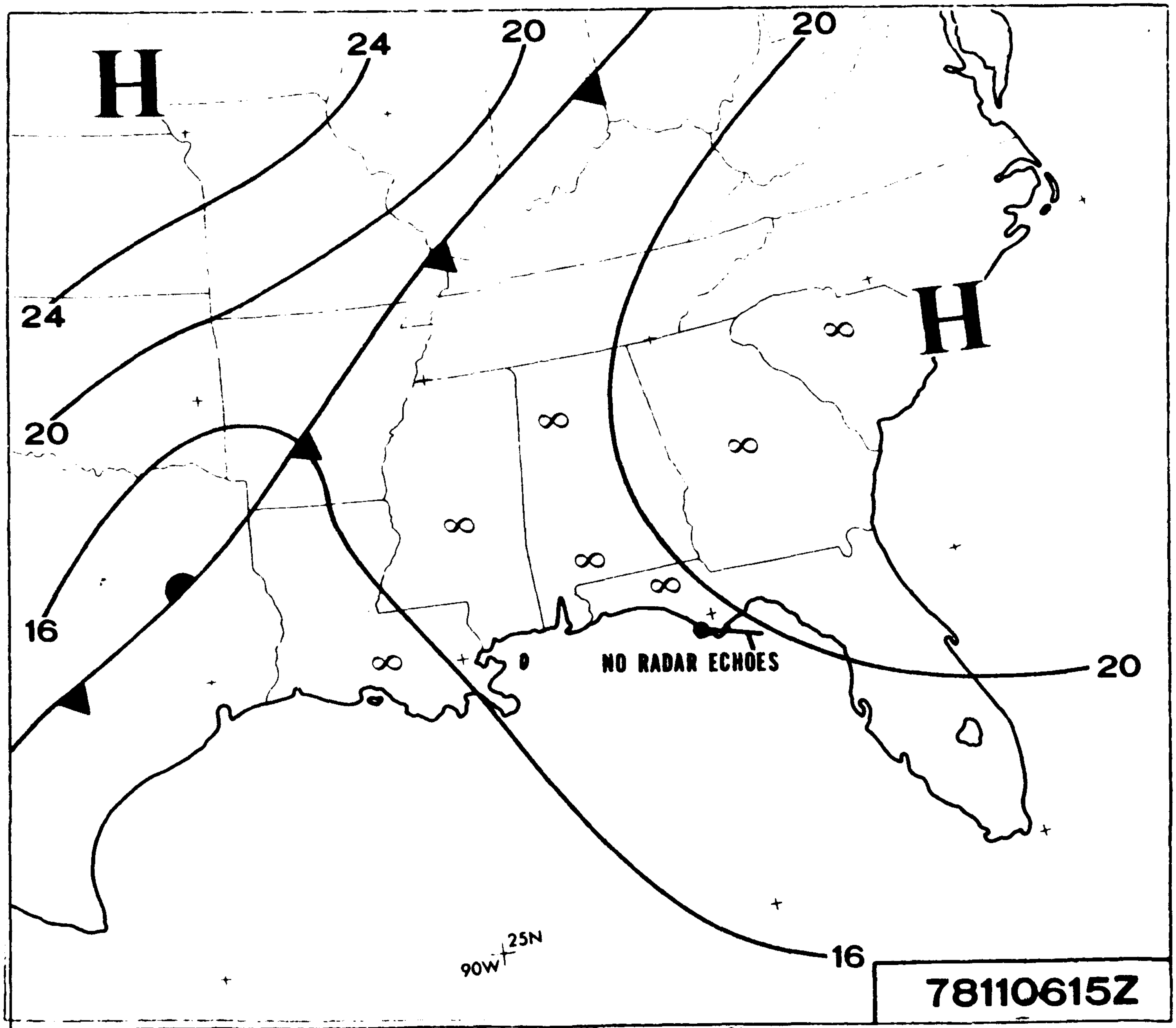


Figure 9-4 78110615Z Synoptic Chart

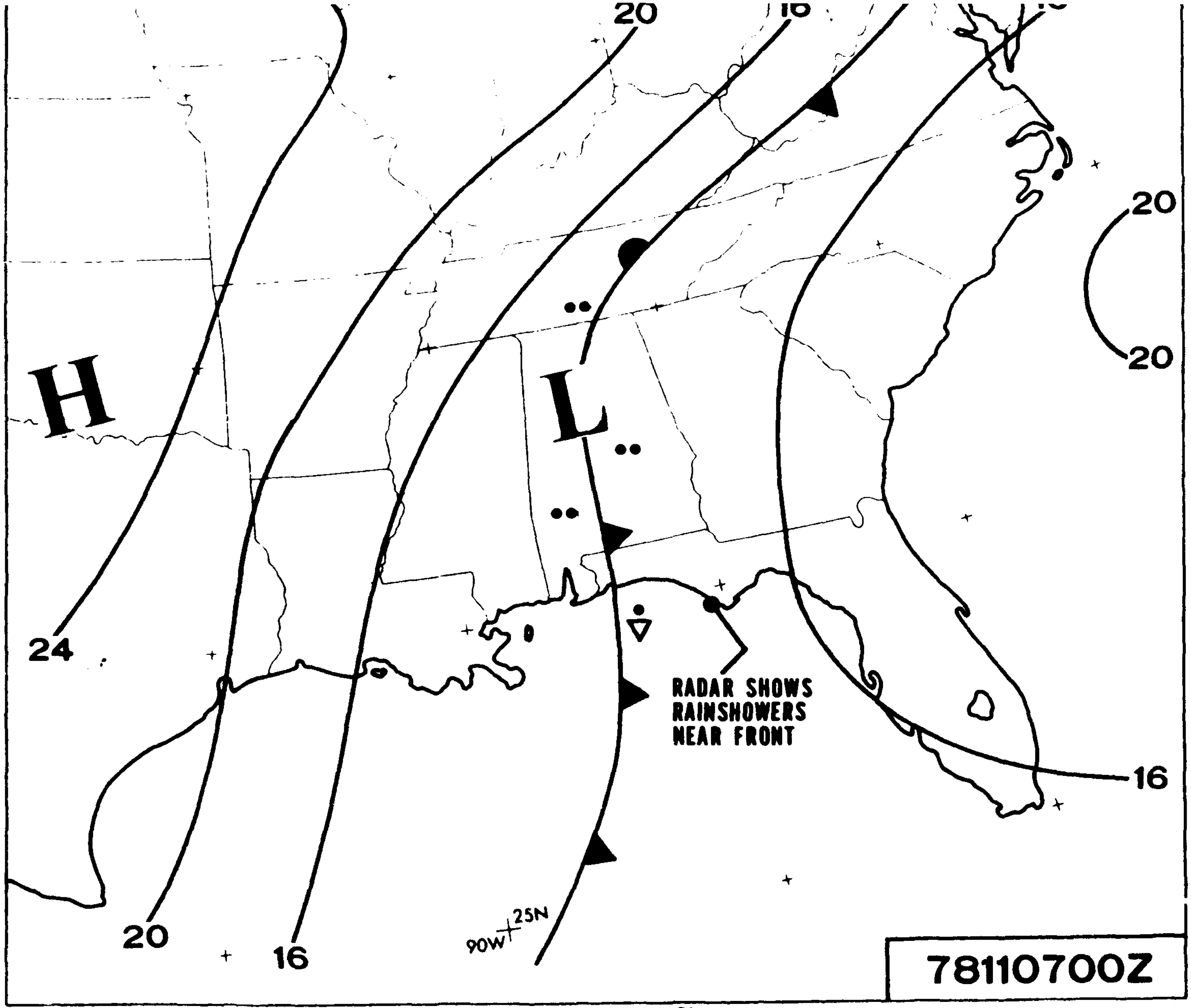


Figure 9-5 78110700Z Synoptic Chart

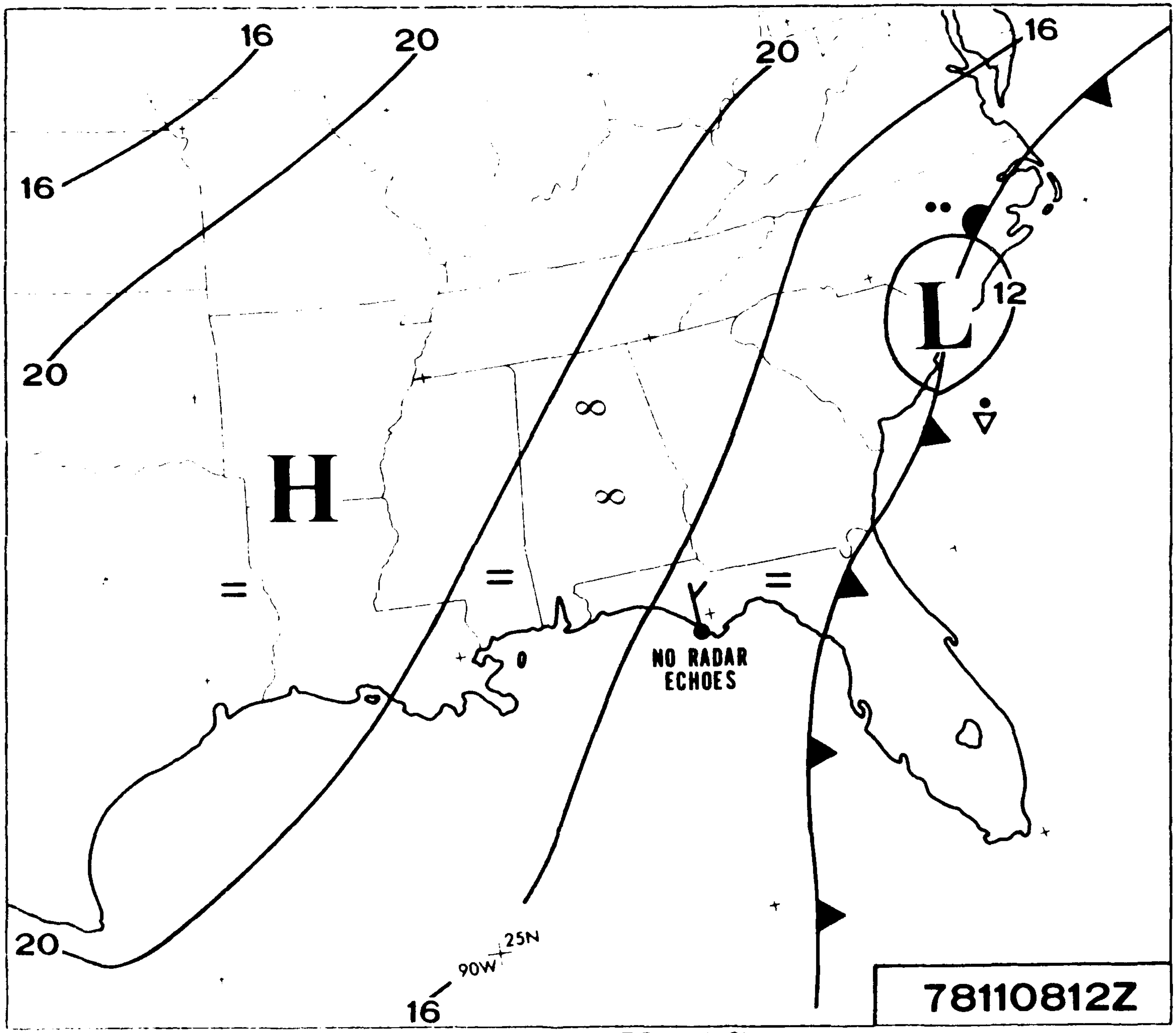


Figure 9-6 78110812Z Synoptic Chart

Table 9-1. Case 9, Apalachicola Surface Weather, 06 Nov 78, 1100Z - 07 Nov 78, 1900Z.

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 06 09	9.4	1.1	CALM	CALM	CLR	7	None
12	11.2	0.5	40	4	CLR	4	GF H
15	21.2	6.1	160	9	BKN	7	None
18	23.4	6.6	170	9	SCT	7	None
21	21.8	6.1	140	10	BKN	7	None
11 07 00	20.1	3.9	150	9	SCT	7	None
03	20.1	5.0	170	5	SCT	7	None
06	20.1	3.3	180	6	SCT	7	None
09	20.1	1.7	190	5	SCT	7	None
12	20.1	1.1	190	4	OVC	7	None
15	22.9	2.2	180	8	OVC	5	H
18	20.1	0.5	290	8	OVC	4	TRW H
21	20.7	0.6	270	6	OVC	5	RW F

Table 9-2. Case 9, Tyndall Surface Weather, 06 Nov 78, 1100Z - 07 Nov 78, 1900Z.

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 06 11	12.8	3.4	70	6	CLR	5	F
12	12.8	3.4	70	4	CLR	5	F
15	21.1	8.3	90	6	SCT	6	H
18	25.6	12.3	180	4	SCT	7	None
21	24.4	12.2	140	4	SCT	10	None
11 07 00	20.6	5.6	140	4	CLR	10	None
03	17.8	3.4	110	2	CLR	7	None
06	16.7	2.8	130	2	CLR	5	F
09	17.8	3.4	120	4	SCT	7	None
12	22.8	3.9	160	6	OVC	7	None
1500	23.9	4.5	160	9	OVC	7	None
1509	--	--	160	10	OVC	7	R-
1548	--	--	170	8	OVC	7	None
1607	--	--	180	6	OVC	5	R-
1616	--	--	170	9	OVC	7	None
1625	--	--	190	9	OVC	5	R-
1636	--	--	180	12	OVC	4	RW-
1640	--	--	170	9	OVC	1½	RW
1646	--	--	160	6	OVC	5	F
1653	--	--	180	10	OVC	5	F
1700	23.3	3.3	180	12	OVC	6	F

Table 9-2. Case 9, Tyndall Surface Weather, 06 Nov 78, 1100Z - 07 Nov 78, 1900Z (Cont'd).

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 07 1735	--	--	200	8	OVC	6	R-
1744	--	--	200	8	OVC	6	R-
1800	22.8	3.4	200	9	OVC	6	R-
1825	--	--	200	10	OVC	$1\frac{1}{2}$	RW
1835	--	--	260	4	OVC	$\frac{3}{4}$	RW+
1839	--	--	240	5	BKN	$1\frac{1}{4}$	RW
1844	--	--	220	3	BKN	2	RW-
1849	--	--	250	2	OVC	4	F
1853	--	--	230	2	BKN	4	R-
1900	21.7	2.3	230	2	BKN	4	R-
1929	--	--	270	3	BKN	4	F

Table 9-3. Case 9, Eglin Surface Weather, 06 Nov 78, 1100Z - 07 Nov 78, 1900Z.

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 06 11	11.7	1.1	CALM	CALM	CLR	6	F
12	11.7	1.1	CALM	CALM	SCT	5	F
15	20.6	7.8	40	4	SCT	6	H
18	24.4	10.0	110	10	SCT	7	None
21	24.4	7.7	120	14	SCT	7	None
11 07 00	22.2	4.4	140	7	BKN	7	None
03	22.8	3.4	140	10	BKN	10	None
06	22.8	4.5	160	8	SCT	14	None
09	23.3	3.9	160	10	SCT	7	None
1145	--	--	160	10	BKN	5	RW-
1200	23.9	2.8	160	10	OVC	5	RW-
1244	--	--	150	12	OVC	5	RW-
1312	--	--	170	12	OVC	$\frac{1}{4}$	R-
1340	--	--	220	10	OVC	$1\frac{1}{2}$	R-
1411	--	--	230	8	OVC	4	R-
1420	--	--	250	8	OVC	6	F
1500	22.2	1.1	240	6	OVC	5	F
1530	--	--	270	7	OVC	6	F
1600	22.2	1.6	300	6	OVC	5	R-
1625	--	--	300	6	OVC	6	F
1800	23.3	4.4	310	8	OVC	8	None
2100	23.3	7.2	320	8	OVC	9	None

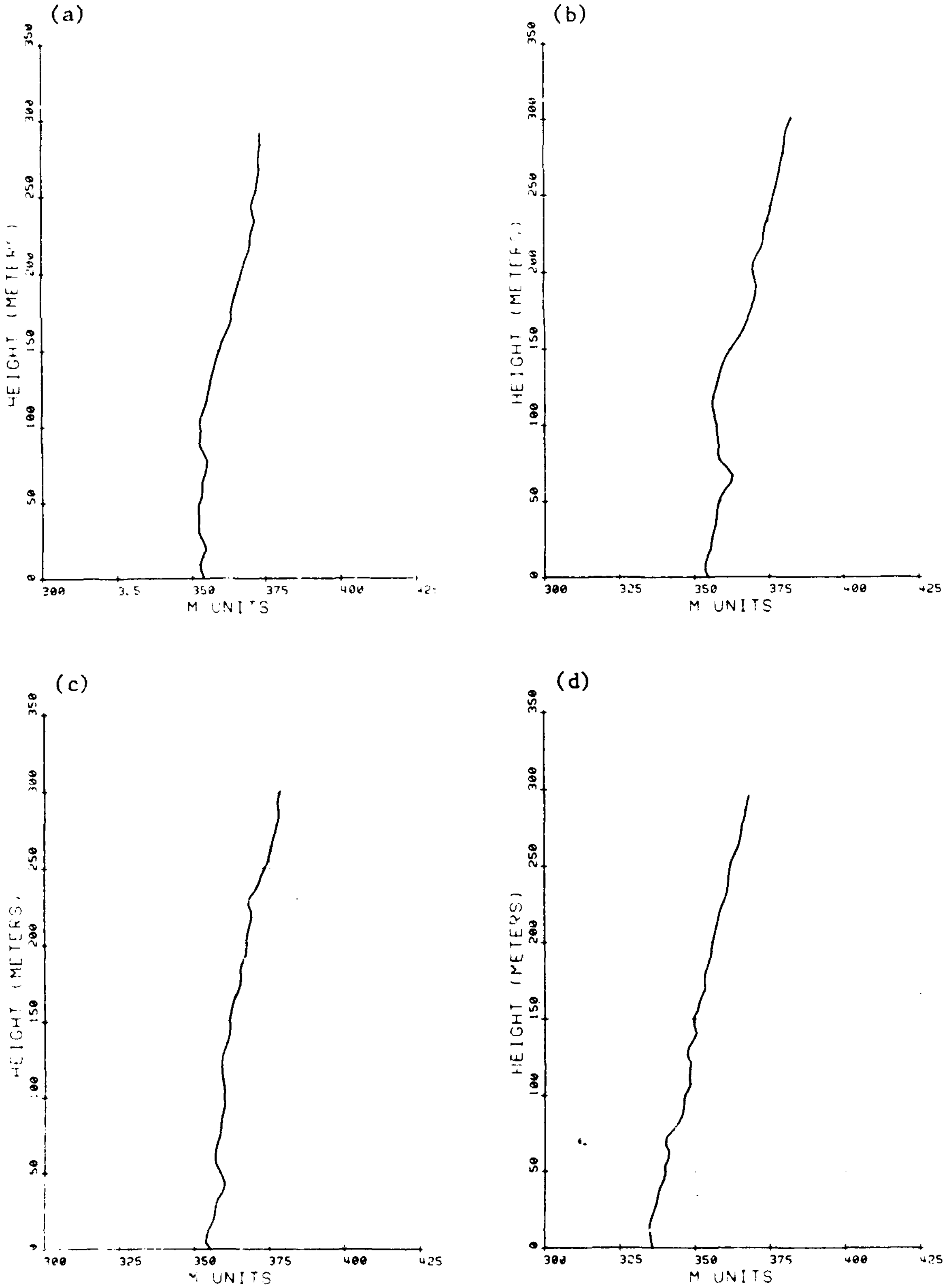


Figure 9-7 Case 9 M-Profiles: a. Cape San Blas, 6 Nov 78, 1000Z; b. Cape San Blas, 6 Nov 78, 1200Z; c. Cape San Blas, 6 Nov 78, 1400Z; d. Cape San Blas, 6 Nov 78, 1600Z.

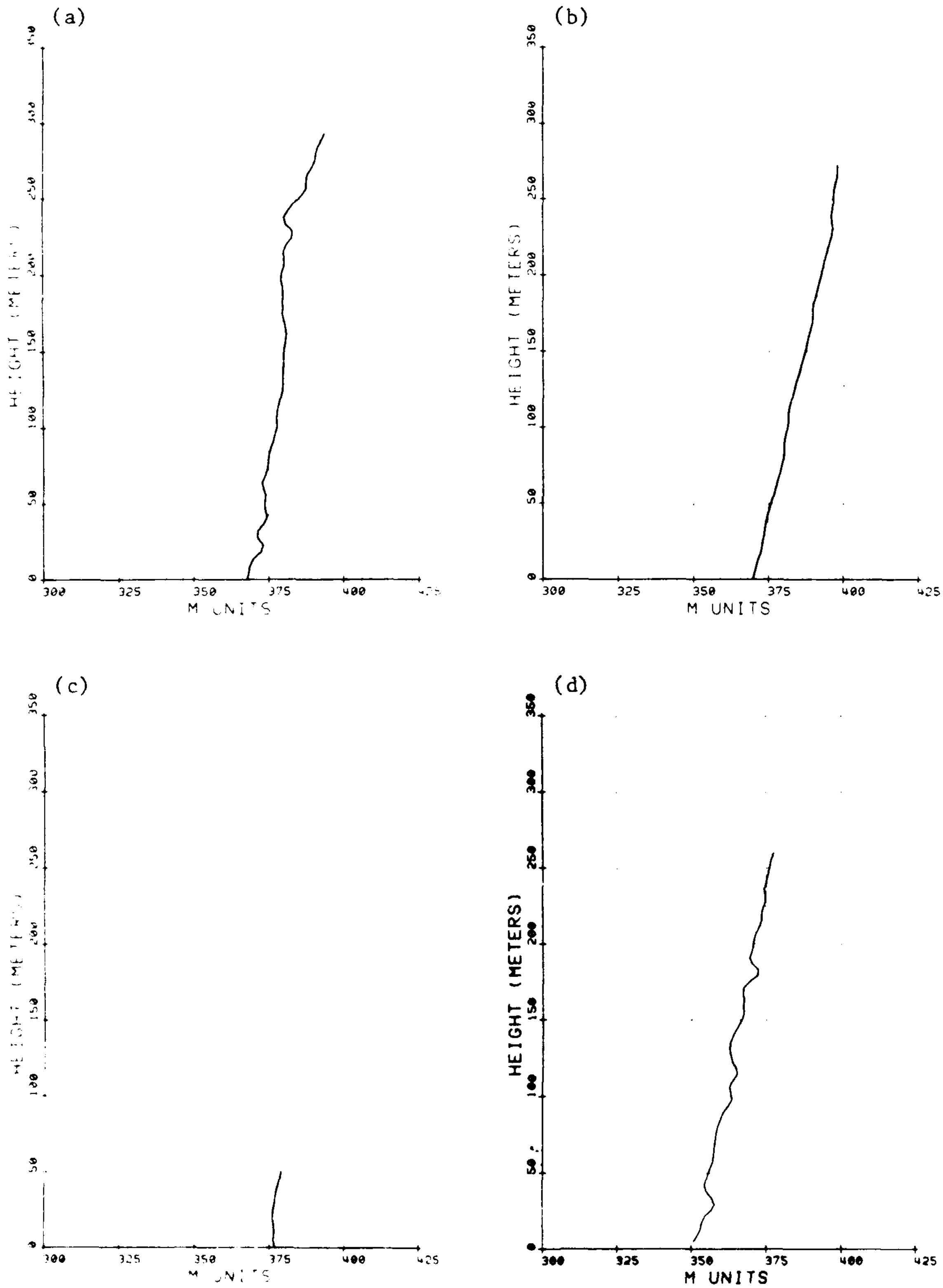


Figure 9-8 Case 9 M-Profiles : a. Cape San Blas, 7 Nov 78, 1000Z, b. Cape San Blas, 7 Nov 78, 1200Z; c. Cape San Blas, 7 Nov 78, 1400Z; d. Apalachicola, 6 Nov 78, 0900Z.

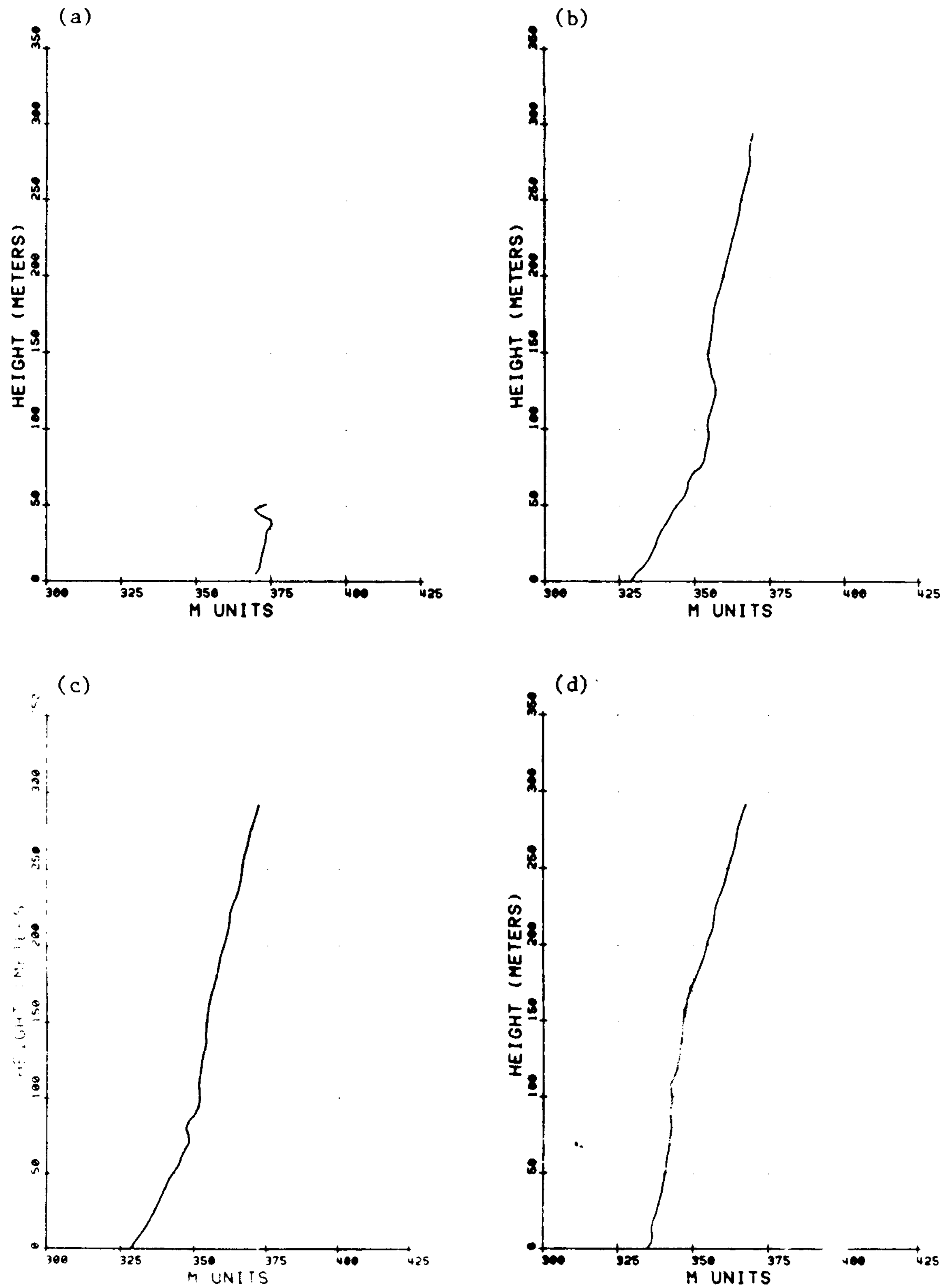


Figure 9-9 Case 9 M-Profiles : a. Apalachicola, 7 Nov 78, 0800Z; b. White City, 6 Nov 78, 1000Z; c. White City, 6 Nov 78, 1200Z; d. White City, 6 Nov 78, 1400Z.

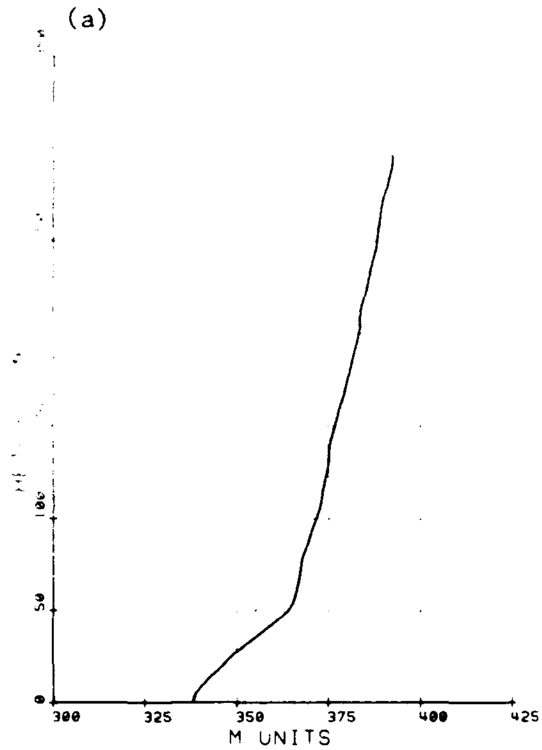


Figure 9-10 Case 9 M-Profile :
a. White City, 7 Nov 78, 0800Z.

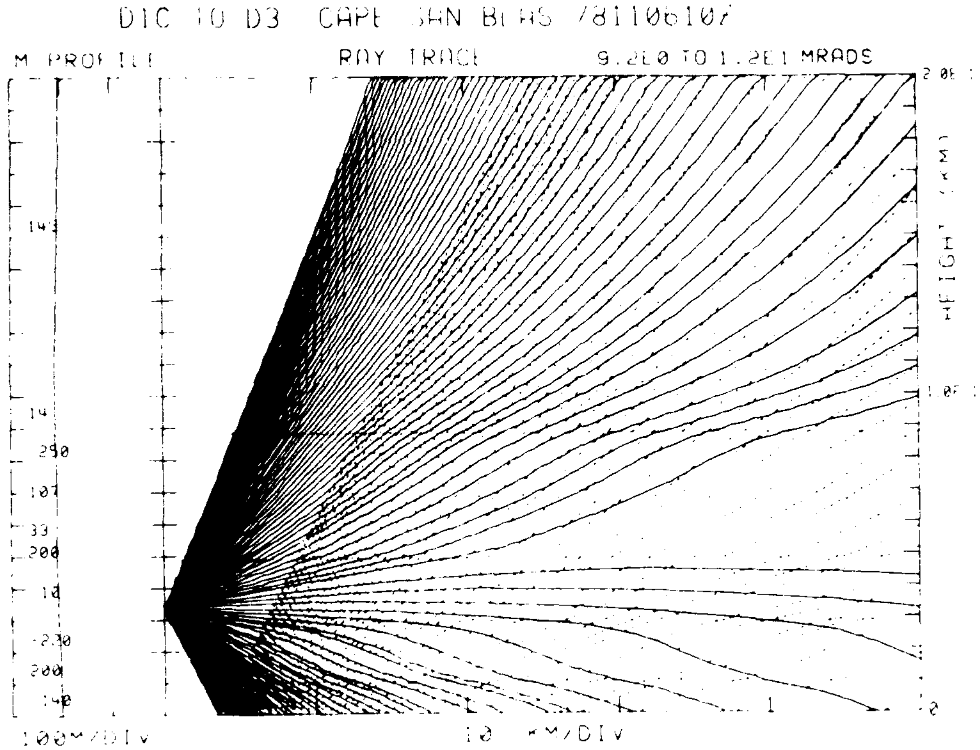


Figure 9-11. Case 9 Raytrace, D1C to D3, Cape San Blas, 6 Nov 78, 1000Z, Transmitter Height 33.5 m.

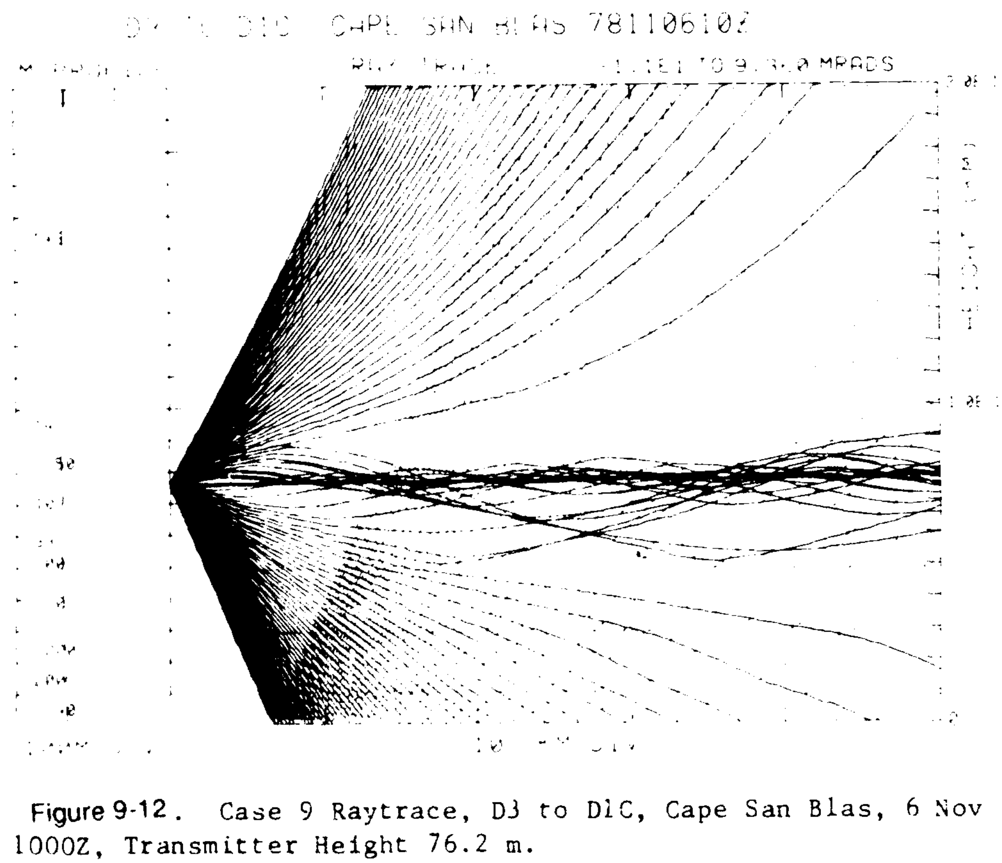


Figure 9-12. Case 9 Raytrace, D3 to D1C, Cape San Blas, 6 Nov 78, 1000Z, Transmitter Height 76.2 m.

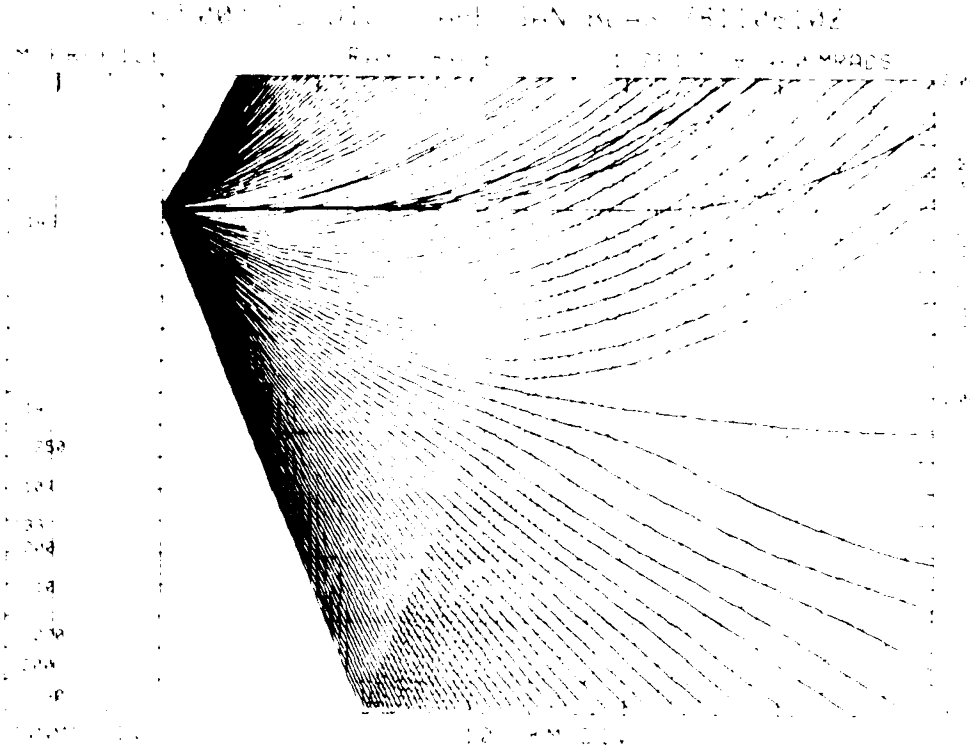


Figure 9-13 . Case 9 Raytrace, D3(500) to D1C, Cape San Blas 6 Nov 78, 1000Z, Transmitter Height 158.4 m.

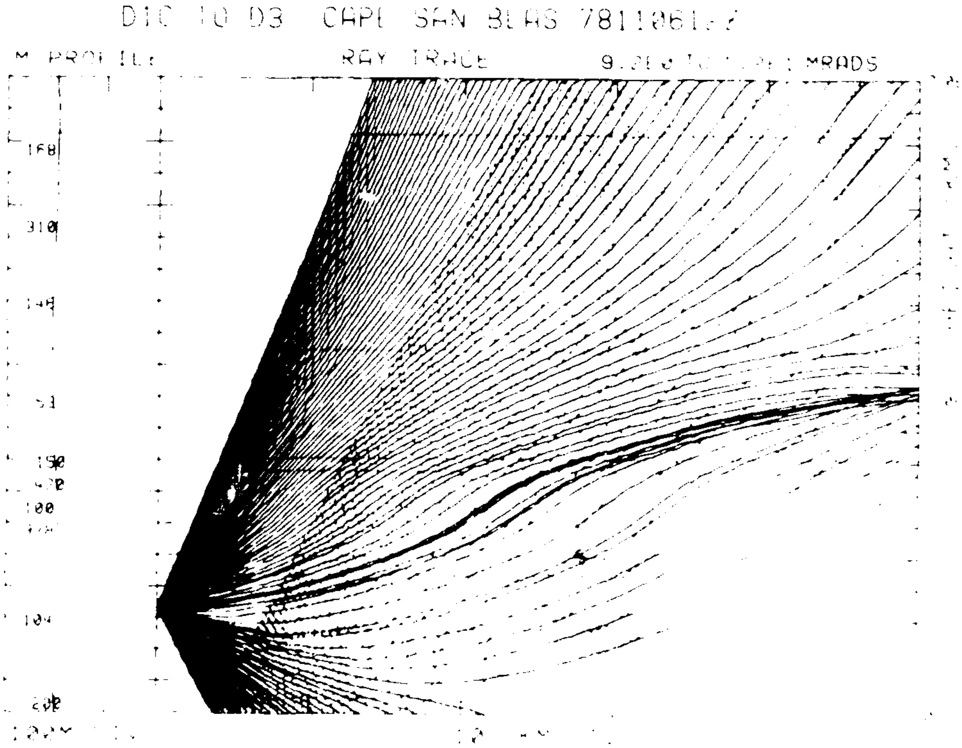


Figure 9-14. Case 9 Raytrace, D1C to D3, Cape San Blas, 6 Nov 78, 1200Z, Transmitter Height 33.5 m.

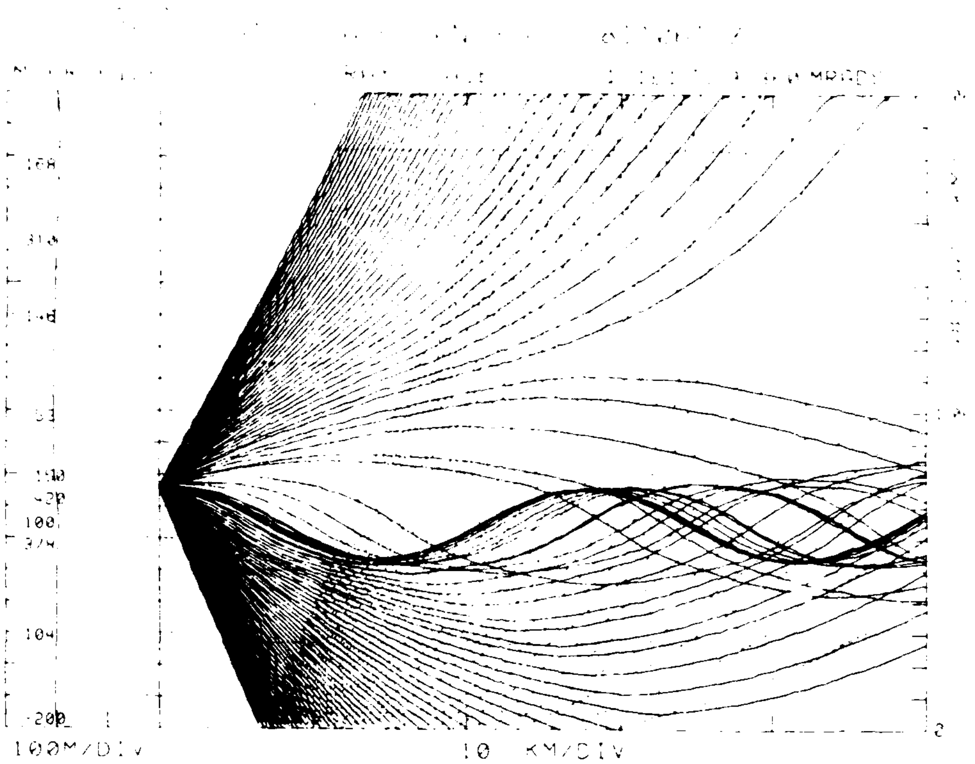


Figure 9-15. Case 9 Raytrace, D3 to D1C, Cape San Blas, 6 Nov 78, 1200Z, Transmitter Height 76.2 m.

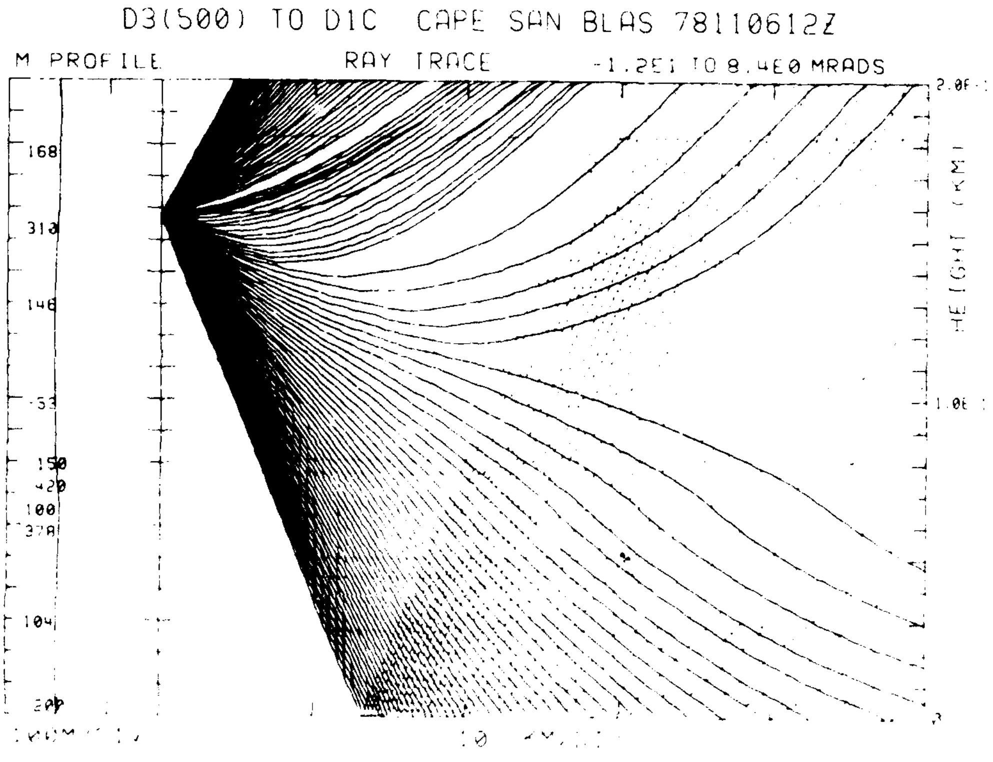


Figure 9-16. Case 9 Raytrace, D3(500) to D1C, Cape San Blas 6 Nov 78, 1200Z, Transmitter Height 158.4 m.

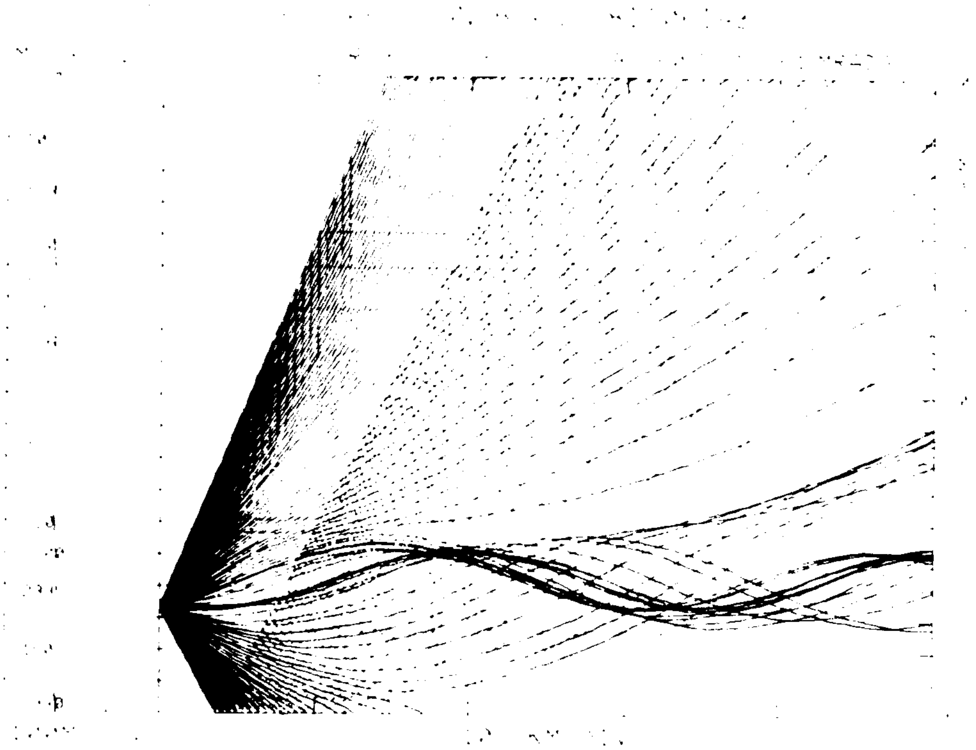


Figure 9-17. Case 9 Raytrace, DIC to D3, Cape San Blas, 6 Nov 78, 1400Z, Transmitter Height 33.5 m.

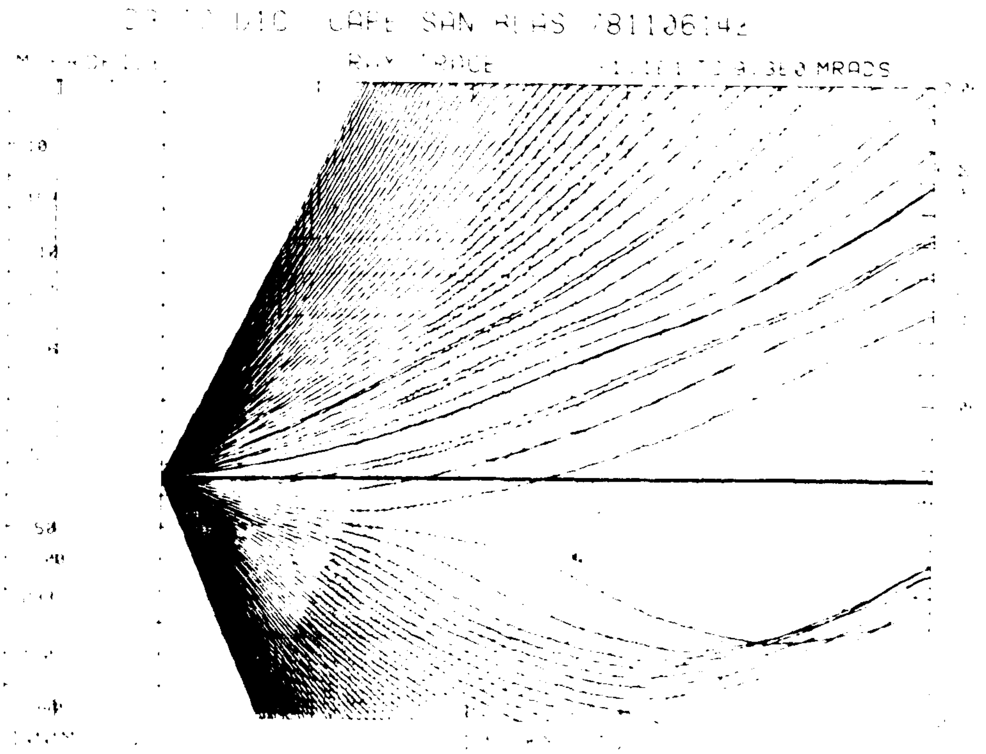


Figure 9-18. Case 9 Raytrace, D3 to DIC, Cape San Blas, 6 Nov 78. 1400Z, Transmitter Height 76.2 m.

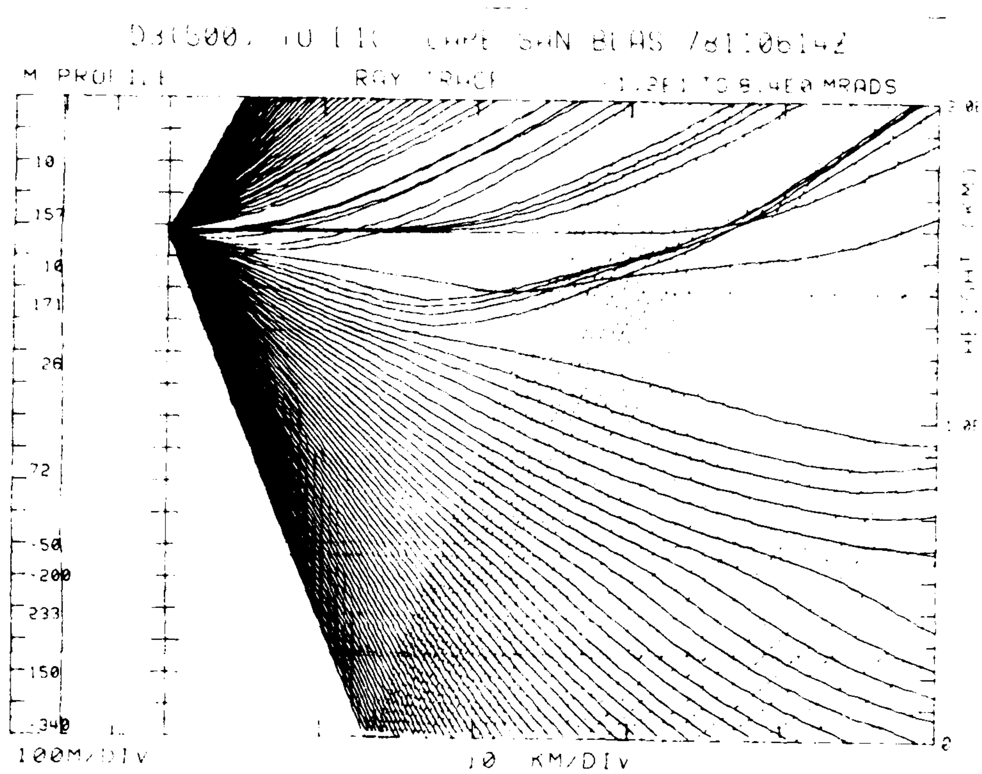


Figure 9-19. Case 9 Raytrace, D3(500) to D1C, Cape San Blas 6 Nov 78, 1400Z, Transmitter Height 158.4 m.

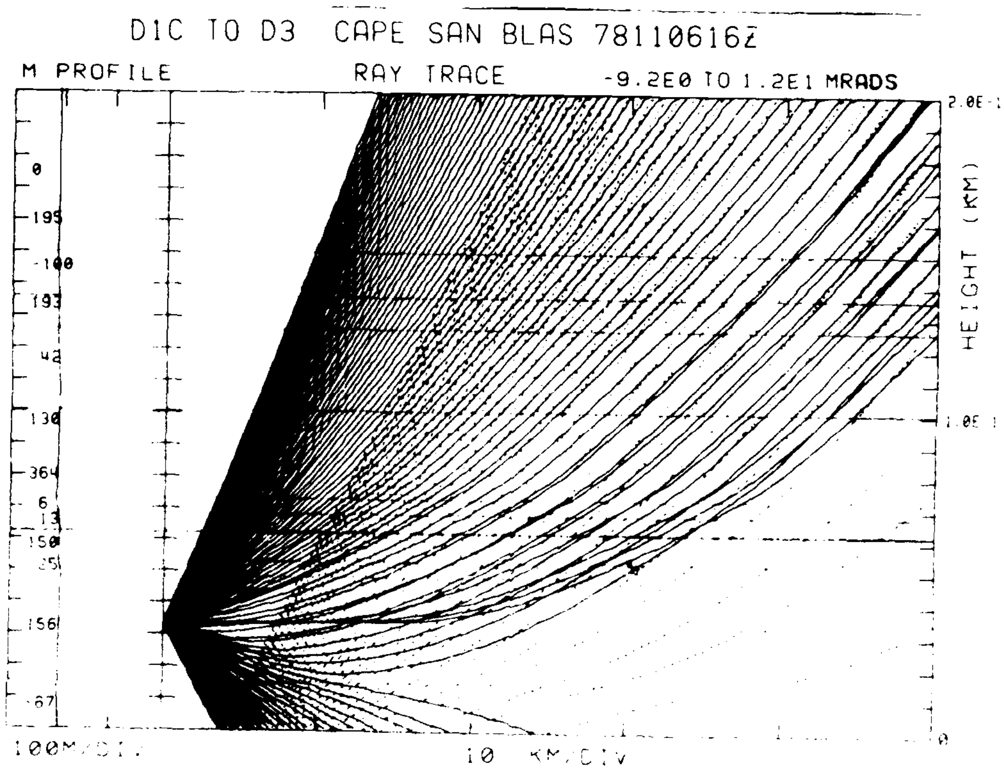


Figure 9-20. Case 9 Raytrace, D1C to D3, Cape San Blas, 6 Nov 78, 1600Z, Transmitter Height 33.5 m.

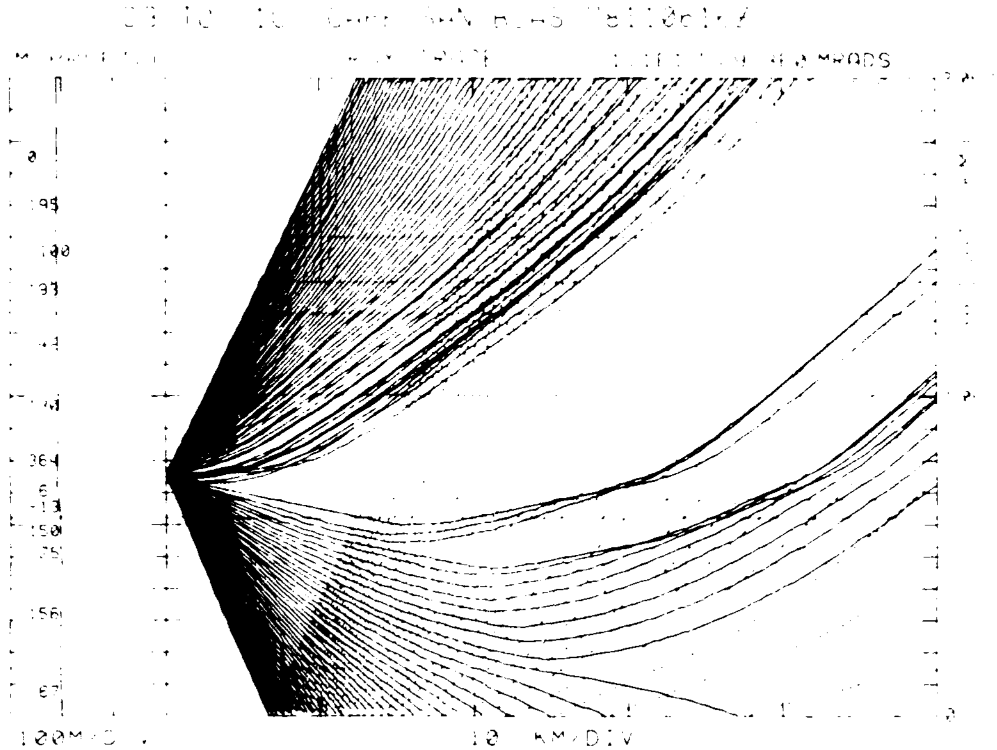


Figure 9-21. Case 9 Raytrace, D3 to D1C, Cape San Blas, 6 Nov 78, 1600Z, Transmitter Height 76.2 m.

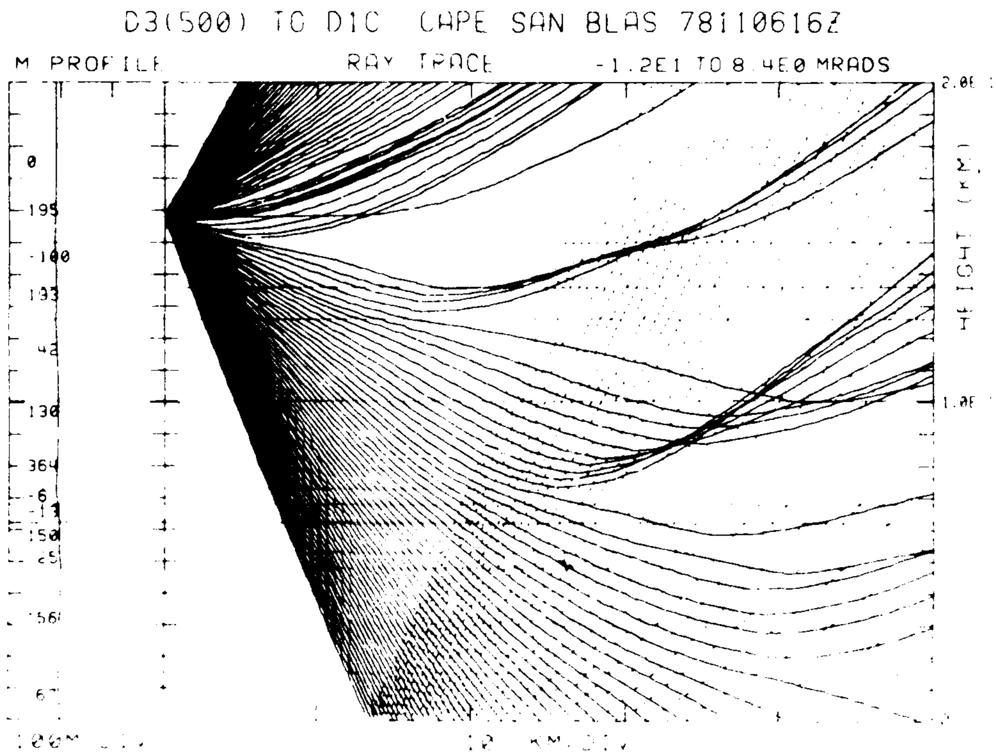


Figure 9-22. Case 9 Raytrace, D3(500) to D1C, Cape San Blas 6 Nov 78, 1600Z, Transmitter Height 158.4 m.

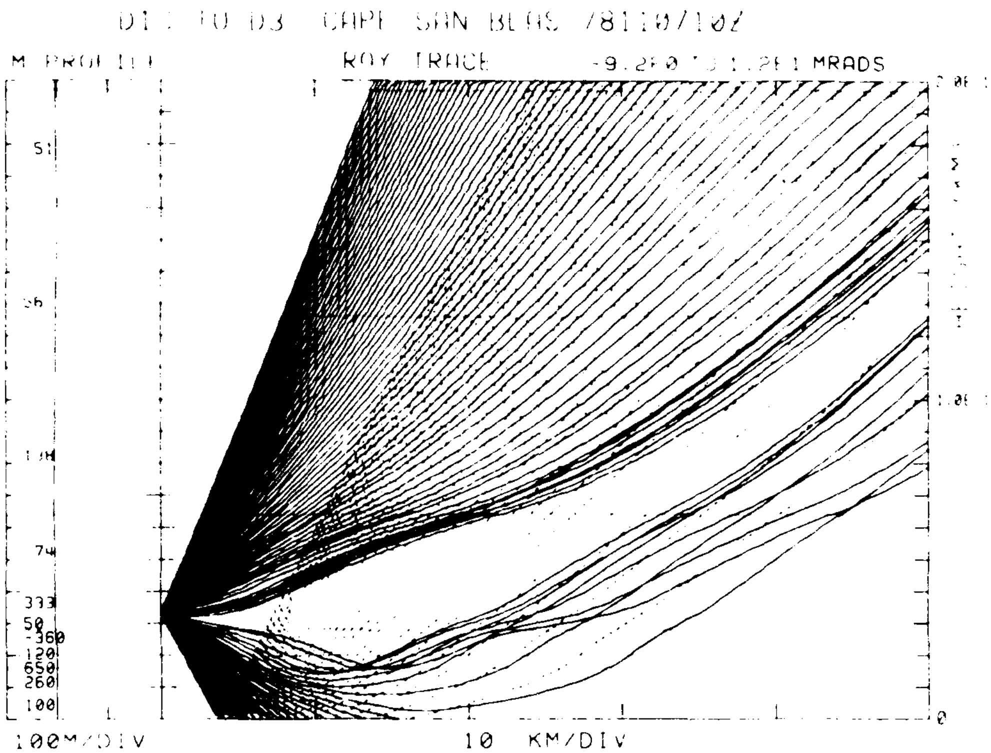


Figure 9-23. Case 9 Raytrace, D1C to D3, Cape San Blas, 7 Nov 78, 1000Z, Transmitter Height 33.5 m.

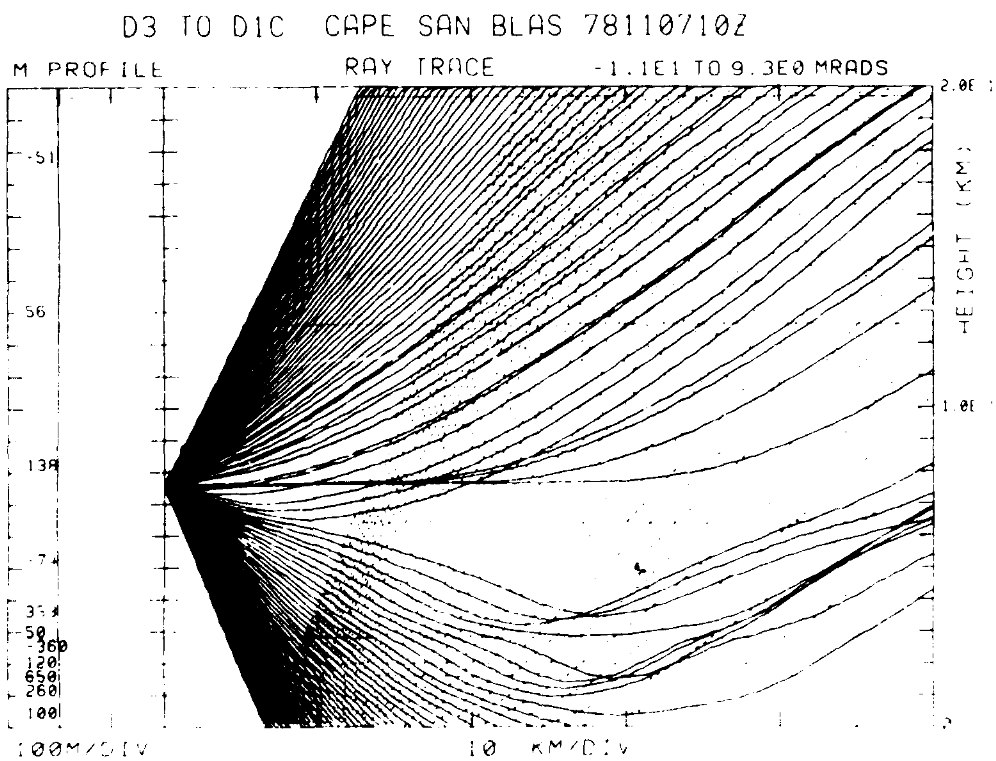


Figure 9-24. Case 9 Raytrace, D3 to D1C, Cape San Blas, 7 Nov 78, 1000Z, Transmitter Height 76.2 m.

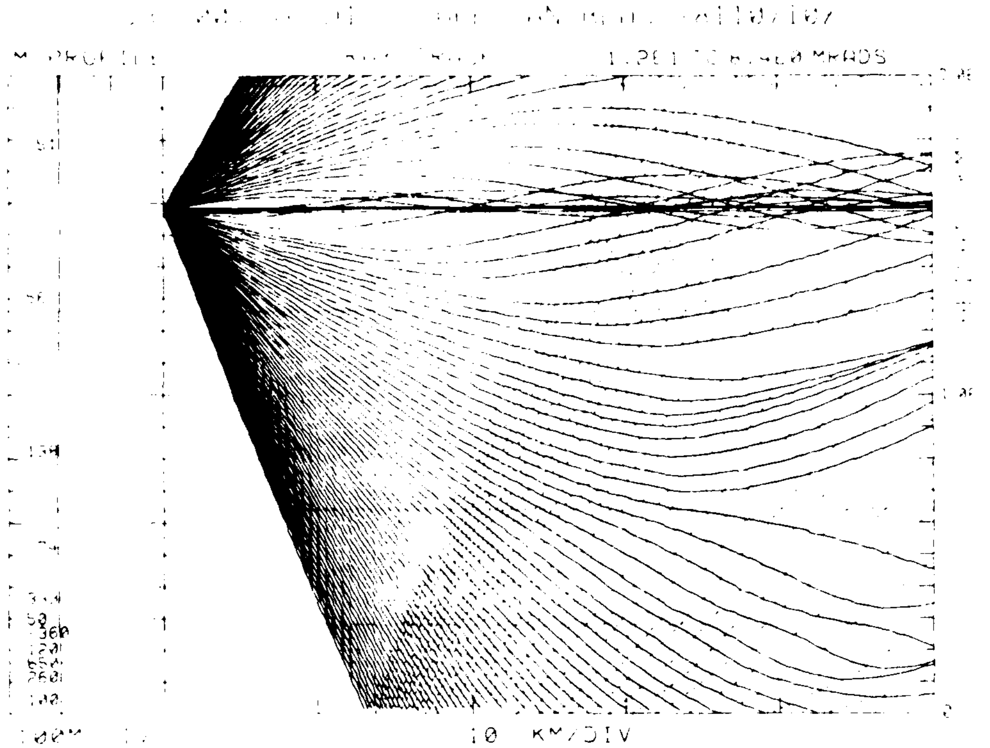


Figure 9-25. Case 9 Raytrace, D3(500) to DlC, Cape San Blas 7 Nov 78, 1000Z, Transmitter Height 158.4 m.

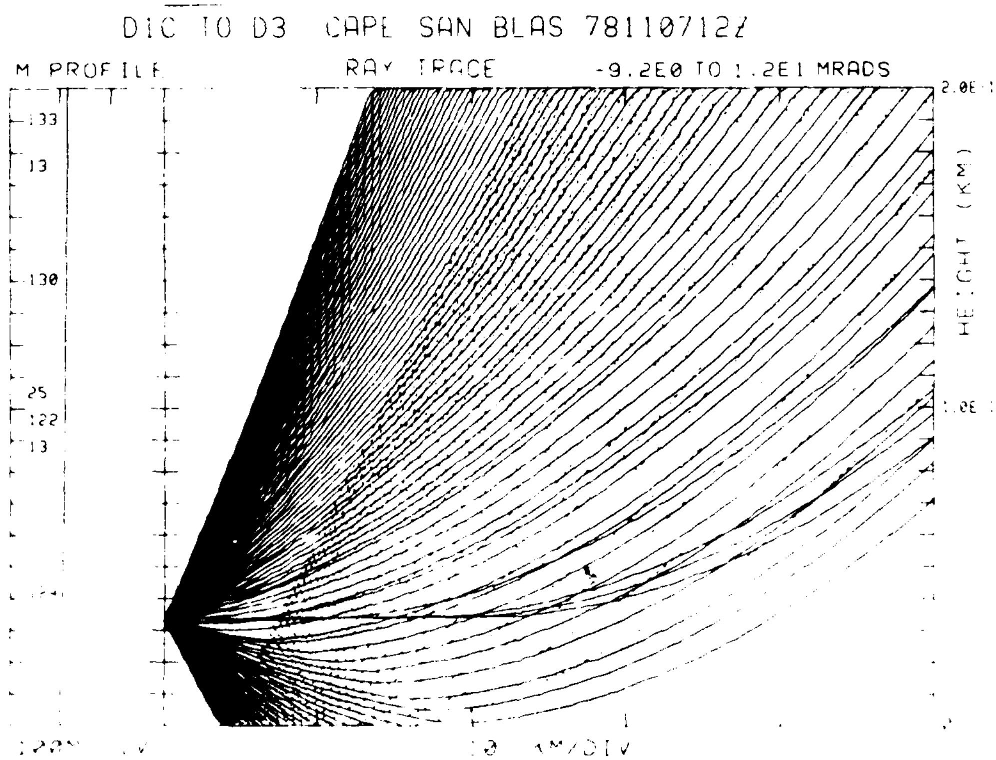


Figure 9-26. Case 9 Raytrace, DlC to D3, Cape San Blas, 7 Nov 78, 1200Z, Transmitter Height 33.5 m.

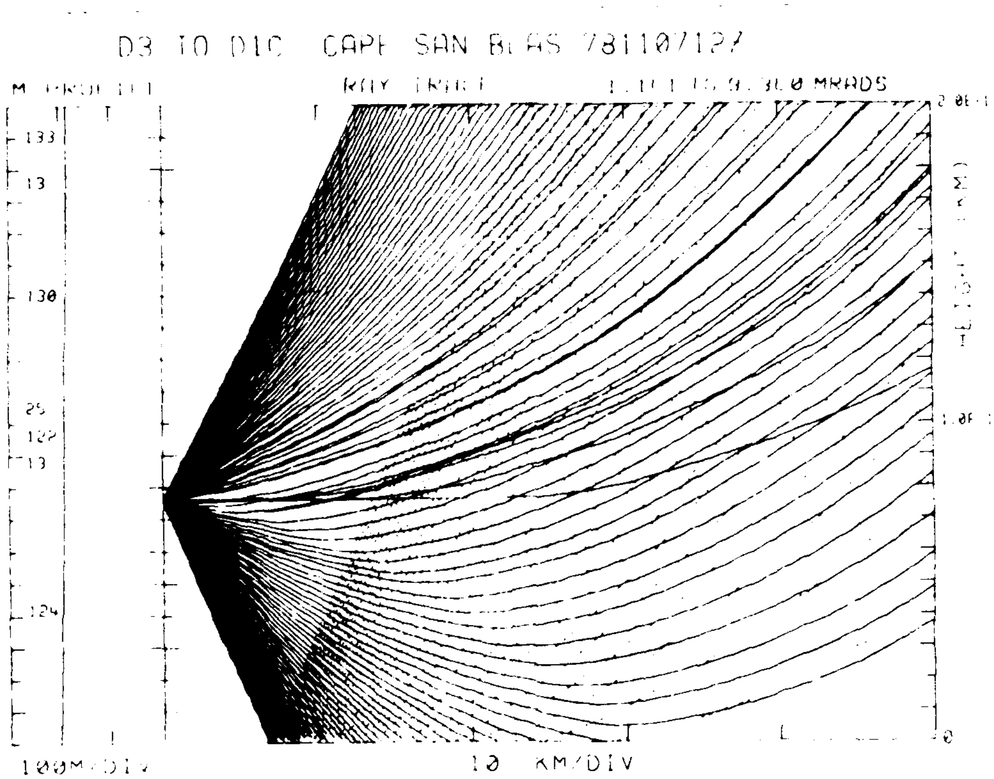


Figure 9-27. Case 9 Raytrace, D3 to D1C, Cape San Blas, 7 Nov 78, 1200Z, Transmitter Height 76.2 m.

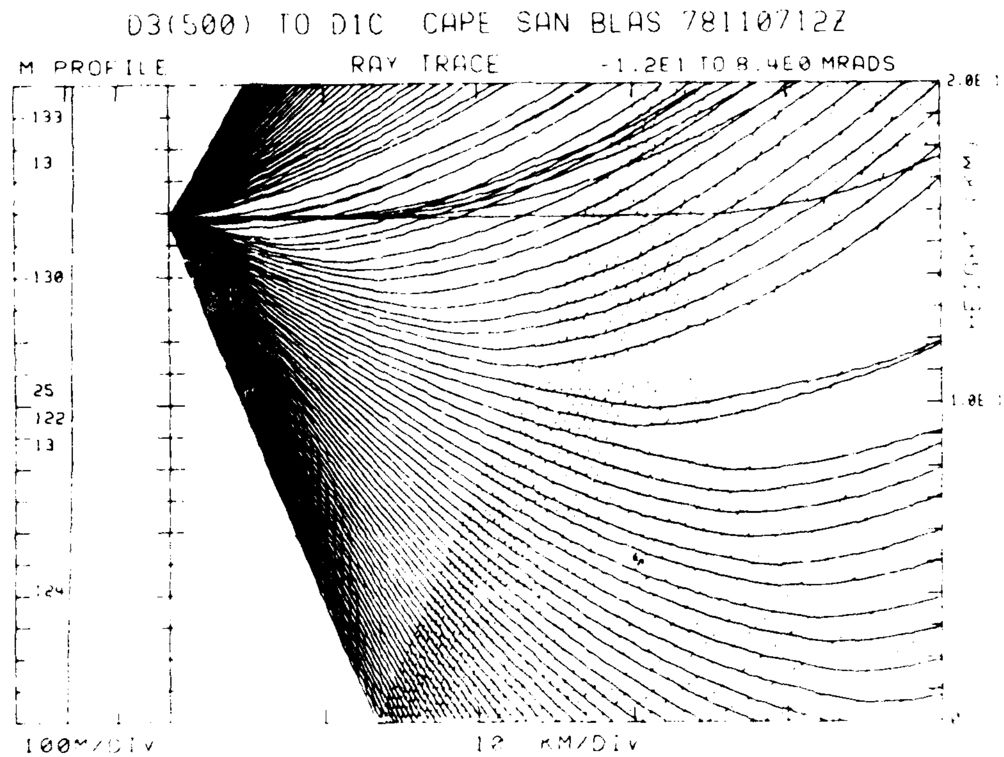


Figure 9-28. Case 9 Raytrace, D3(500) to D1C, Cape San Blas 7 Nov 78, 1200Z, Transmitter Height 158.4 m.

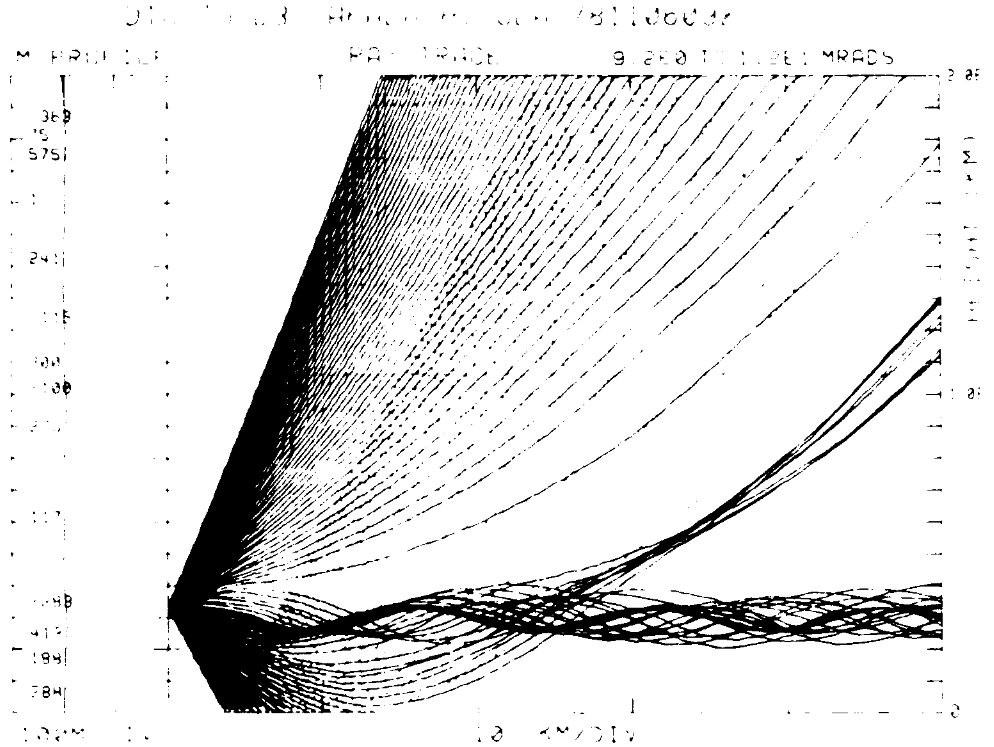


Figure 9-29. Case 9 Raytrace, DlC to D3, Apalachicola, 6 Nov 78, 0900Z, Transmitter Height 33.5 m.

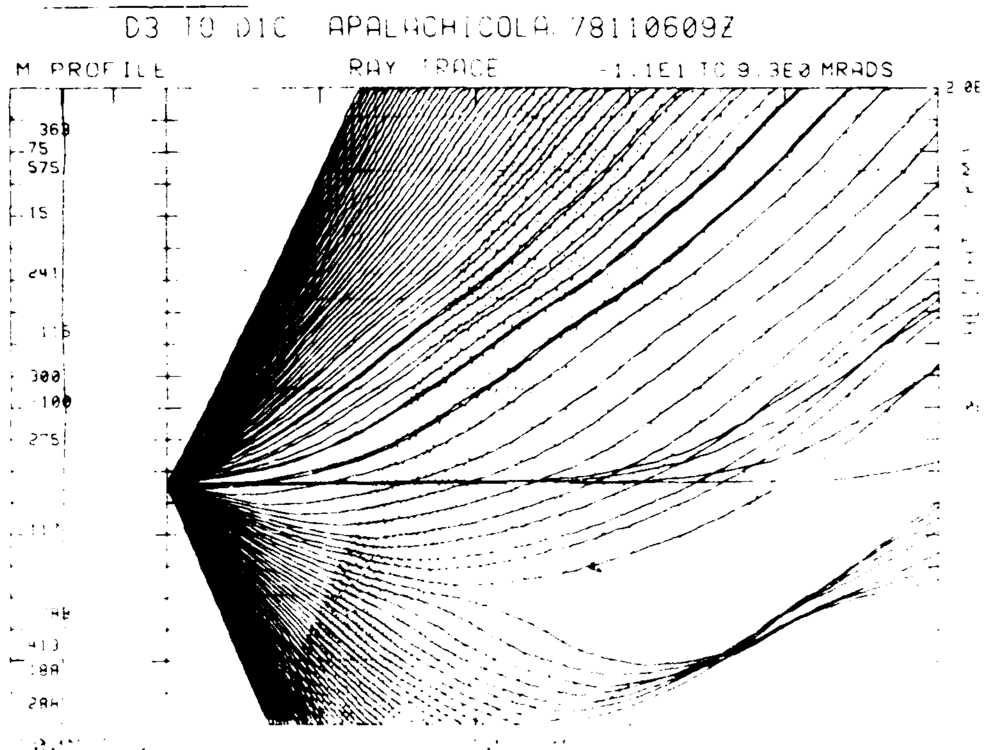


Figure 9-30. Case 9 Raytrace, D3 to DlC, Apalachicola, 6 Nov 78, 0900Z, Transmitter Height 76.2 m.

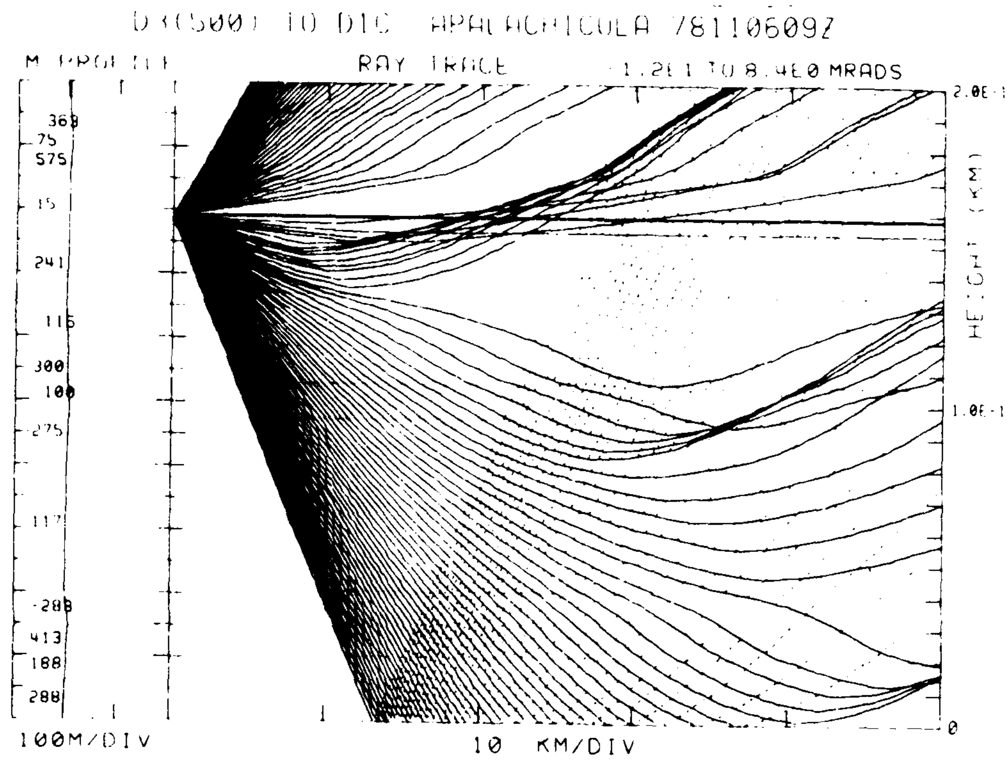


Figure 9-31. Case 9 Raytrace, D3(500) to D1C, Apalachicola 6 Nov 78, 0900Z, Transmitter Height 158.4 m.

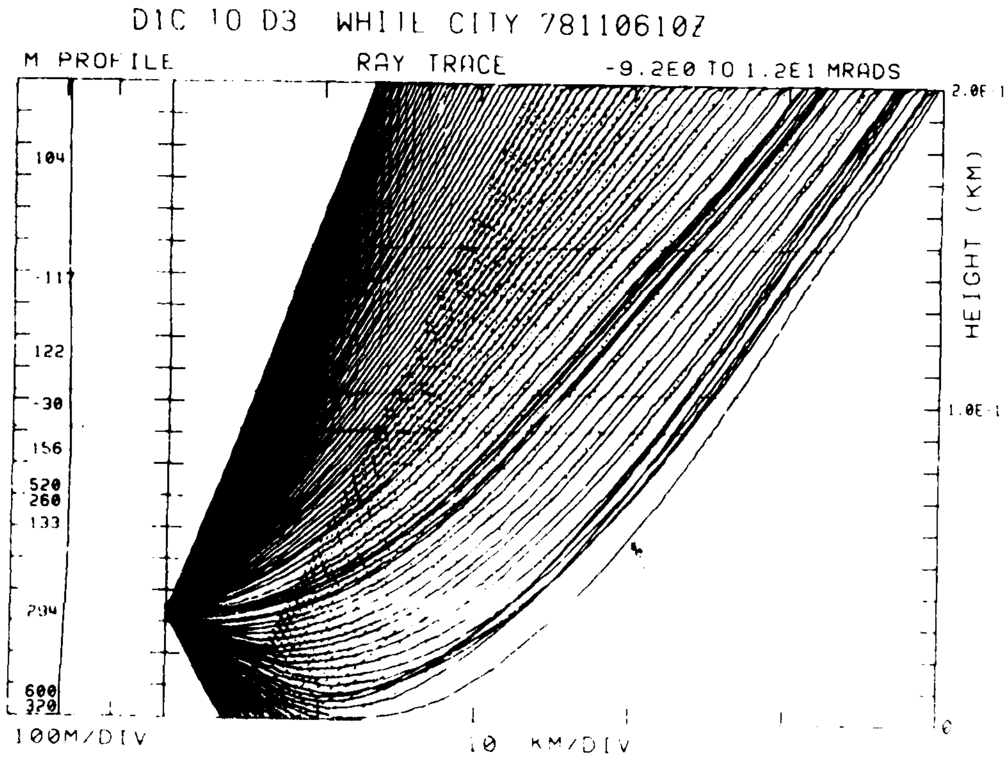


Figure 9-32. Case 9 Raytrace, D1C to D3, White City, 6 Nov 78, 1000Z, Transmitter Height 33.5 m.

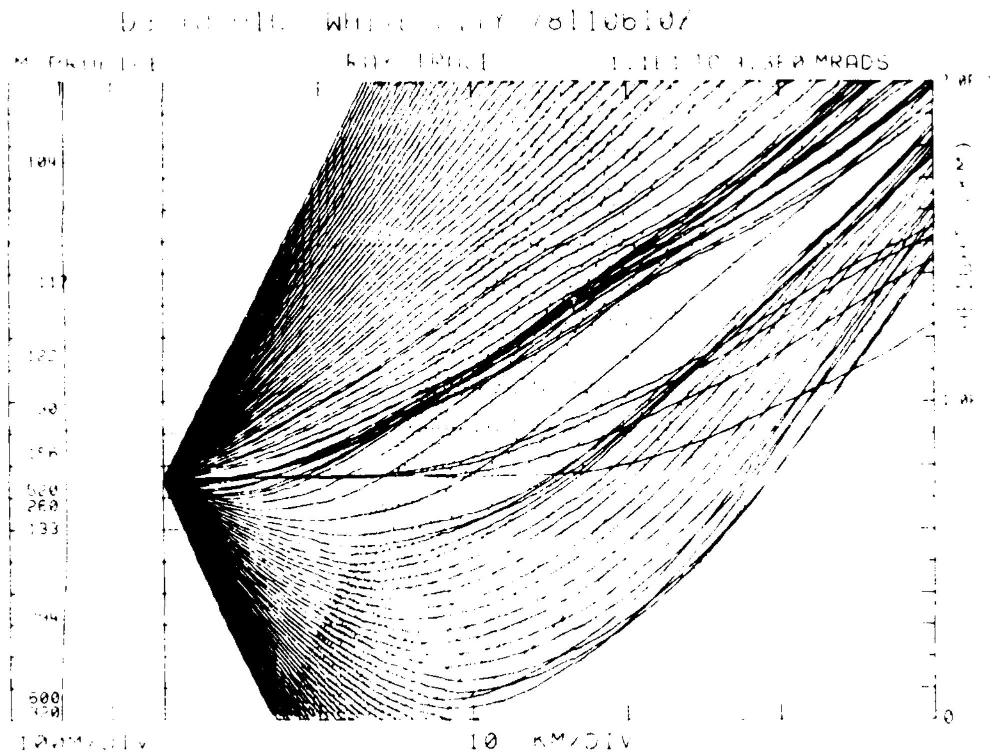


Figure 9-33. Case 9 Raytrace, D3 to DIC, White City, 6 Nov 78, 1000Z, Transmitter Height 76.2 m.

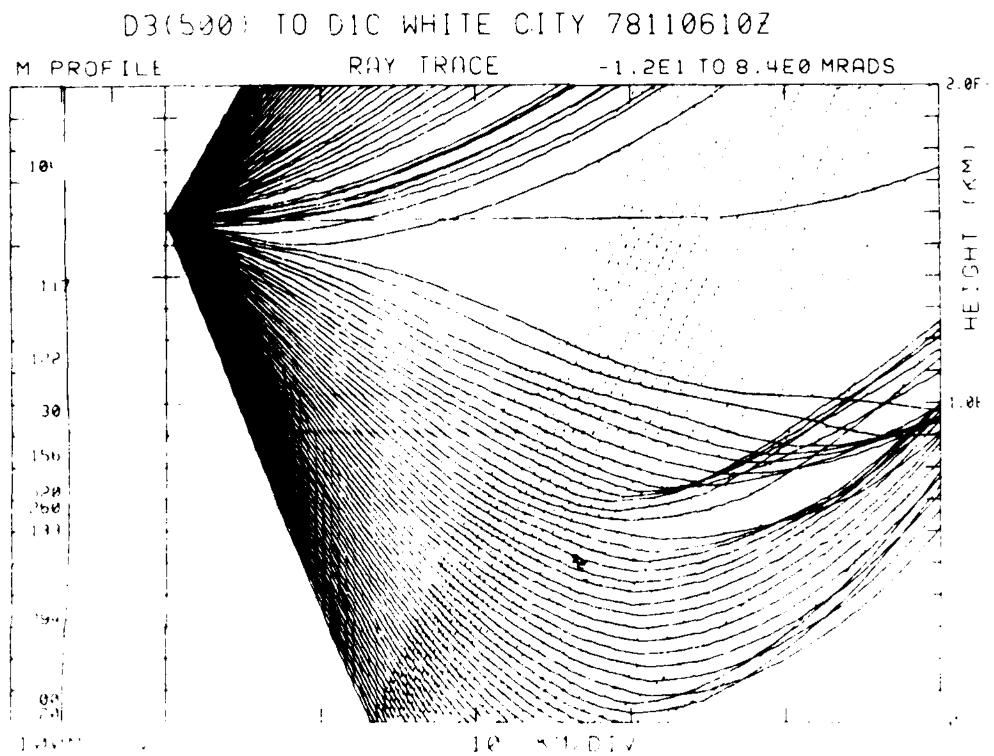


Figure 9-34. Case 9 Raytrace, D3(500) to DIC, White City 6 Nov 78, 1000Z, Transmitter Height 158.4 m.

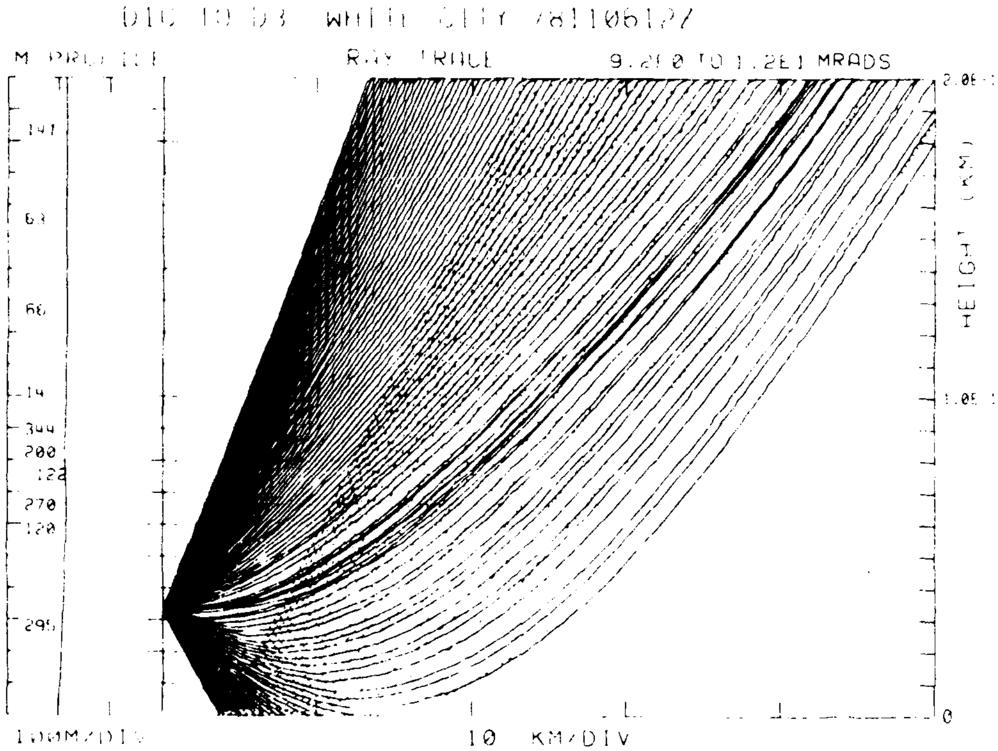


Figure 9-35. Case 9 Raytrace, D1C to D3, White City, 6 Nov 78, 1200Z, Transmitter Height 33.5 m.

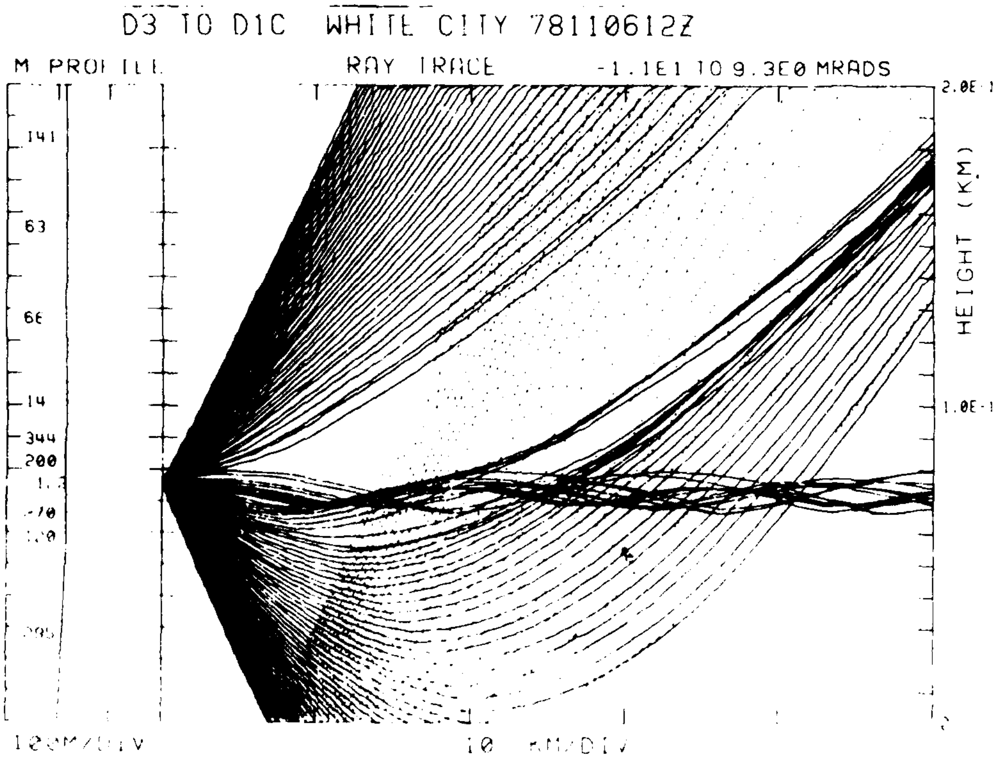


Figure 9-36. Case 9 Raytrace, D3 to D1C, White City, 6 Nov 78, 1200Z, Transmitter Height 76.2 m.

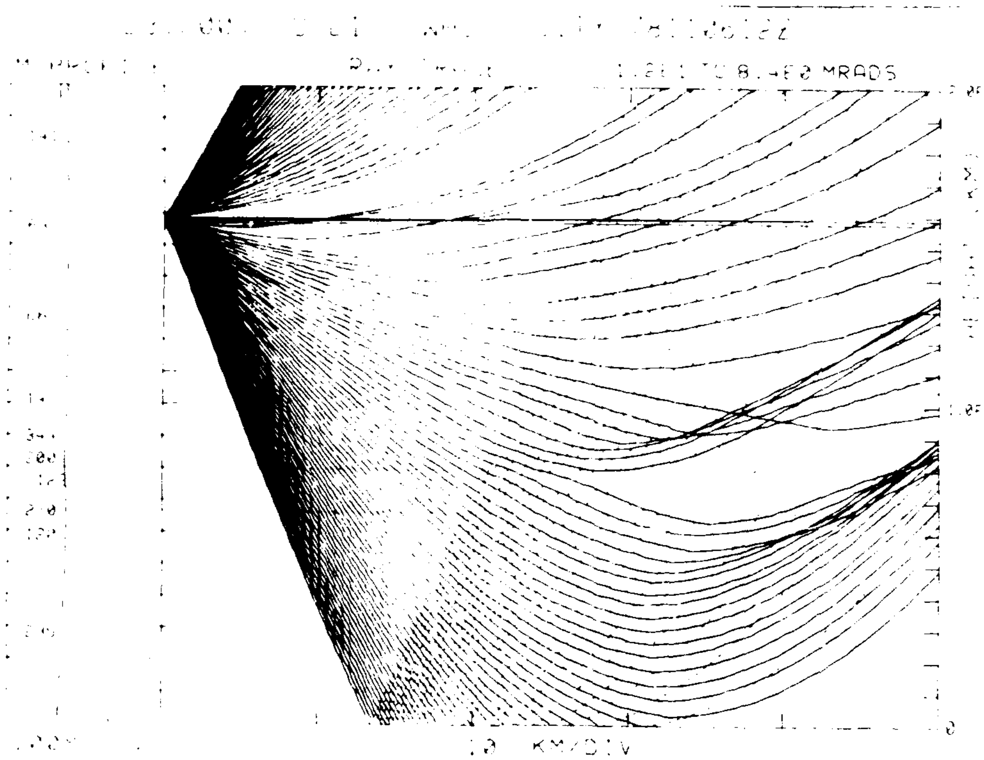


Figure 9-37. Case 9 Raytrace, D3(500) to D1C, White City 6 Nov 78, 1200Z, Transmitter Height 158.4 m.

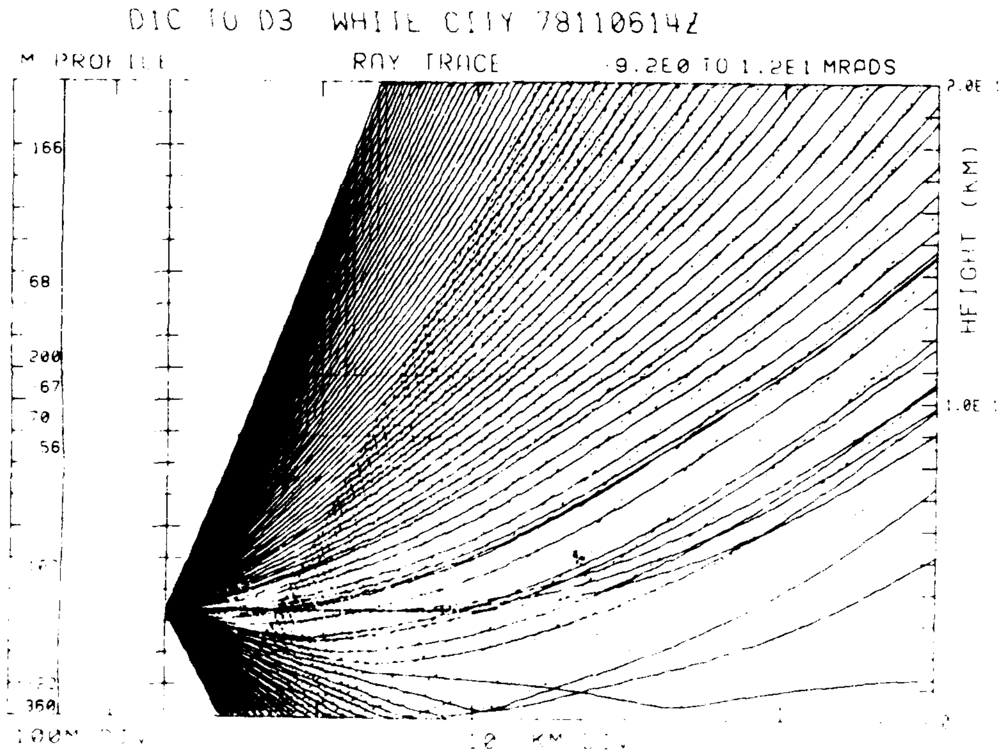


Figure 9-38. Case 9 Raytrace, D1C to D3, White City, 6 Nov 78, 1400Z, Transmitter Height 33.5 m.

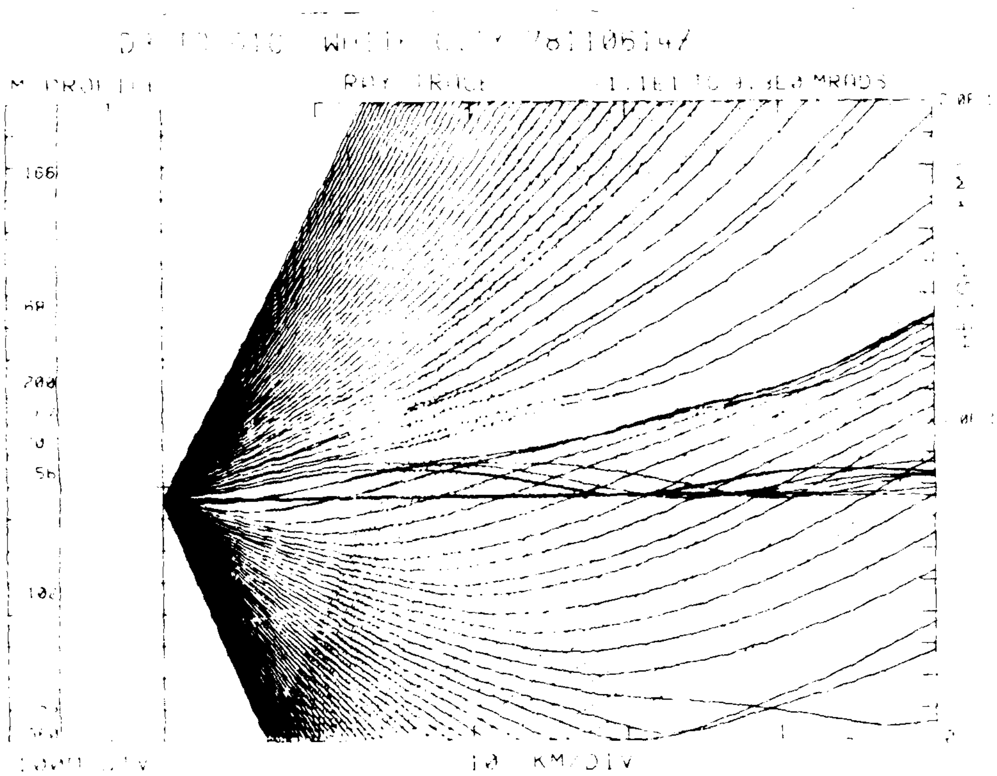


Figure 9-39. Case 9 Raytrace, D3 to D1C, White City, 6 Nov 78, 1400Z, Transmitter Height 76.2 m.

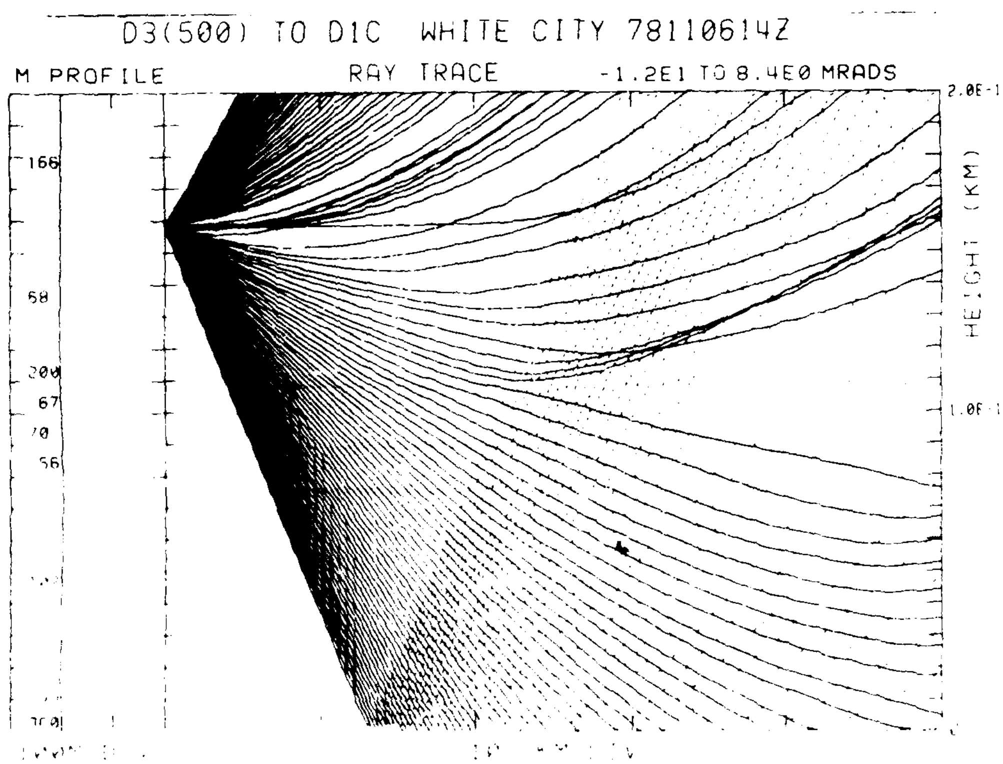


Figure 9-40. Case 9 Raytrace, D3(500) to D1C, White City 6 Nov 78, 1400Z, Transmitter Height 158.4 m.

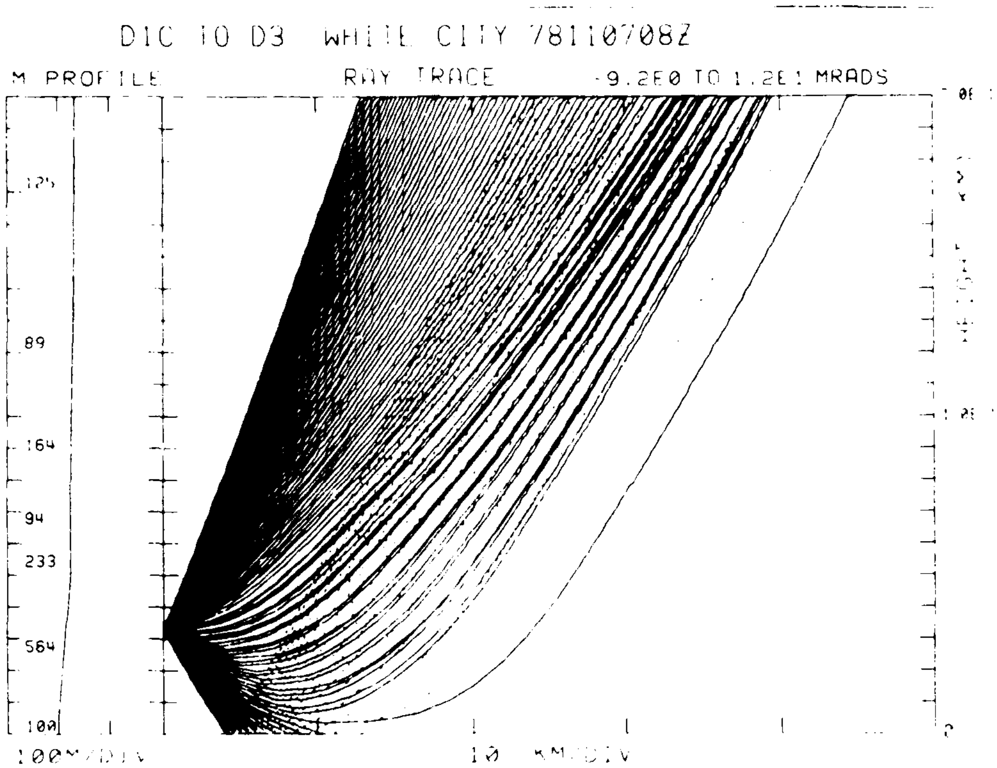


Figure 9-41. Case 9 Raytrace, DlC to D3, White City, 7 Nov 78, 0800Z, Transmitter Height 33 [illegible].

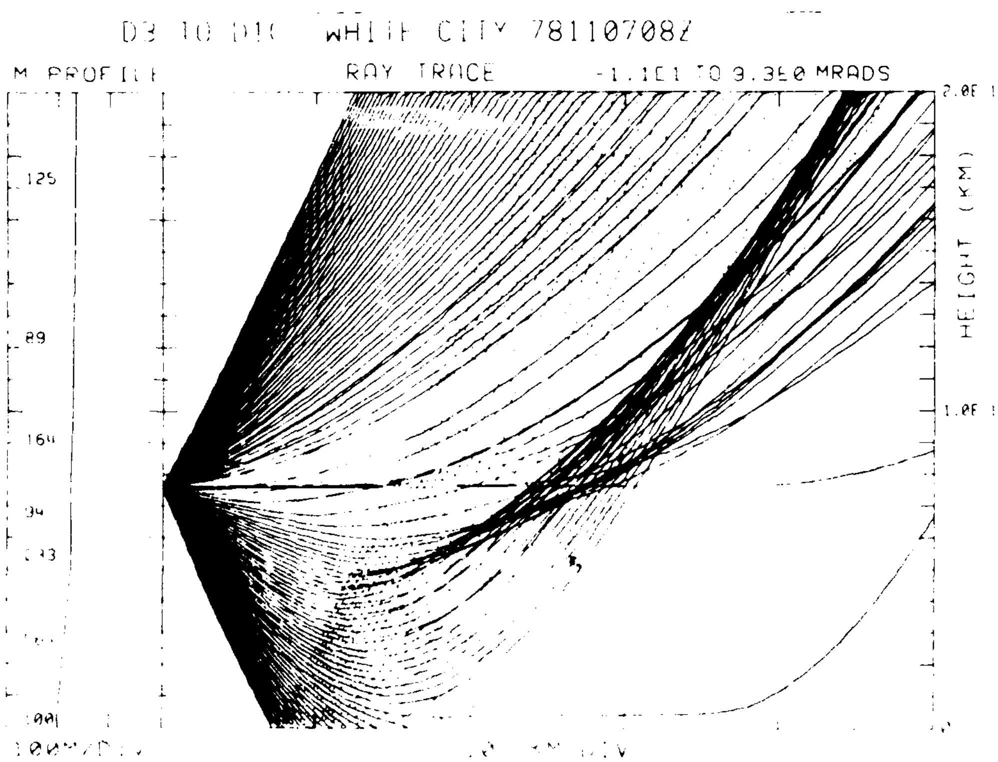


Figure 9-42. Case 9 Raytrace, D3 to DlC, White City, 7 Nov 78, 0800Z, Transmitter Height 76.2 m.

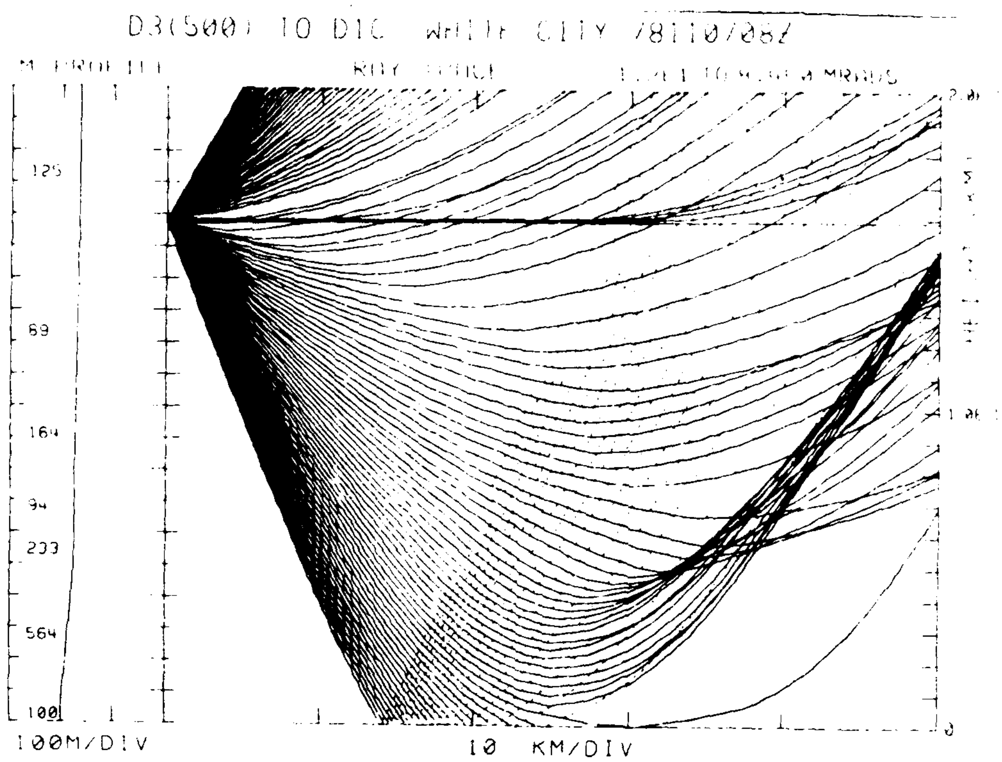


Figure 9-43. Case 9 Raytrace, D3(500) to DIC, White City
7 Nov 78, 0800Z, Transmitter Height 158.4 m.

CASE 10

1. Case 10 (16 Nov/10Z-19 Nov/03Z) was a relatively long "good" period, and represented the RSL at APA as received from D3. Figures 10-1 through 10-3 typified the APA RSLs for both channels as being very stable; however, the median RSL was over 20 dbm below the computed value of -36 dbm. The 1842 EEG attributed this condition to poor antenna alignment on the D3-APA path.

2. Figures 10-4 through 10-11 show the synoptic pattern for this period. As in Case 9, the distinguishing feature was a cold frontal passage. Even though the surface pressure gradient was weak at the beginning and end of the period, no "dome" of high pressure or strong subsiding air was present.

3. Tables 10-1 through 10-3 indicate the observed surface weather at the three reporting stations for this period. They reflect the frontal passage and the expected precipitation for the period.

4. The M-profiles for this period are shown in Figures 10-12 through 10-15. Both Cape San Blas and Apalachicola are represented. Little consistency in the structure of the profiles is evident. More pronounced ducts appeared at Cape San Blas and Apalachicola for 16 Nov/08Z, but they did not persist. These ducts were observed in the transition period between a bad RSL period (Case 6) and this case.

5. Raytraces for this period are shown in Figures 10-16 through 10-35. Many showed considerable pattern disruptions, even though the RSL was stable. This serves to further emphasize the care that must be taken when using a simple geometrical optics raytrace program in analysis of a highly complex propagation problem.

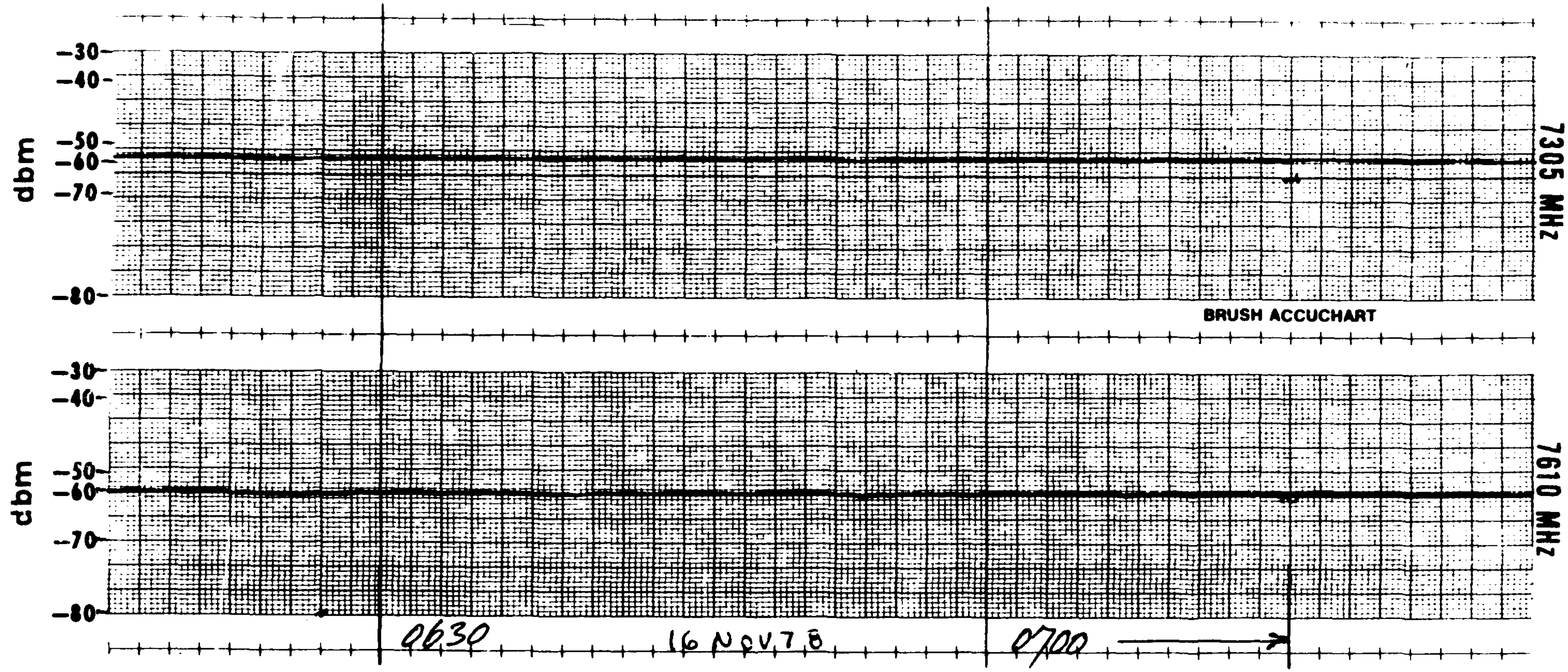


Figure 10-1 Case 10 RSL Strip Chart showing typical stable pattern on both channels of APA received from D3. Times are from 0621 EST to 0708 EST, 16 Nov 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

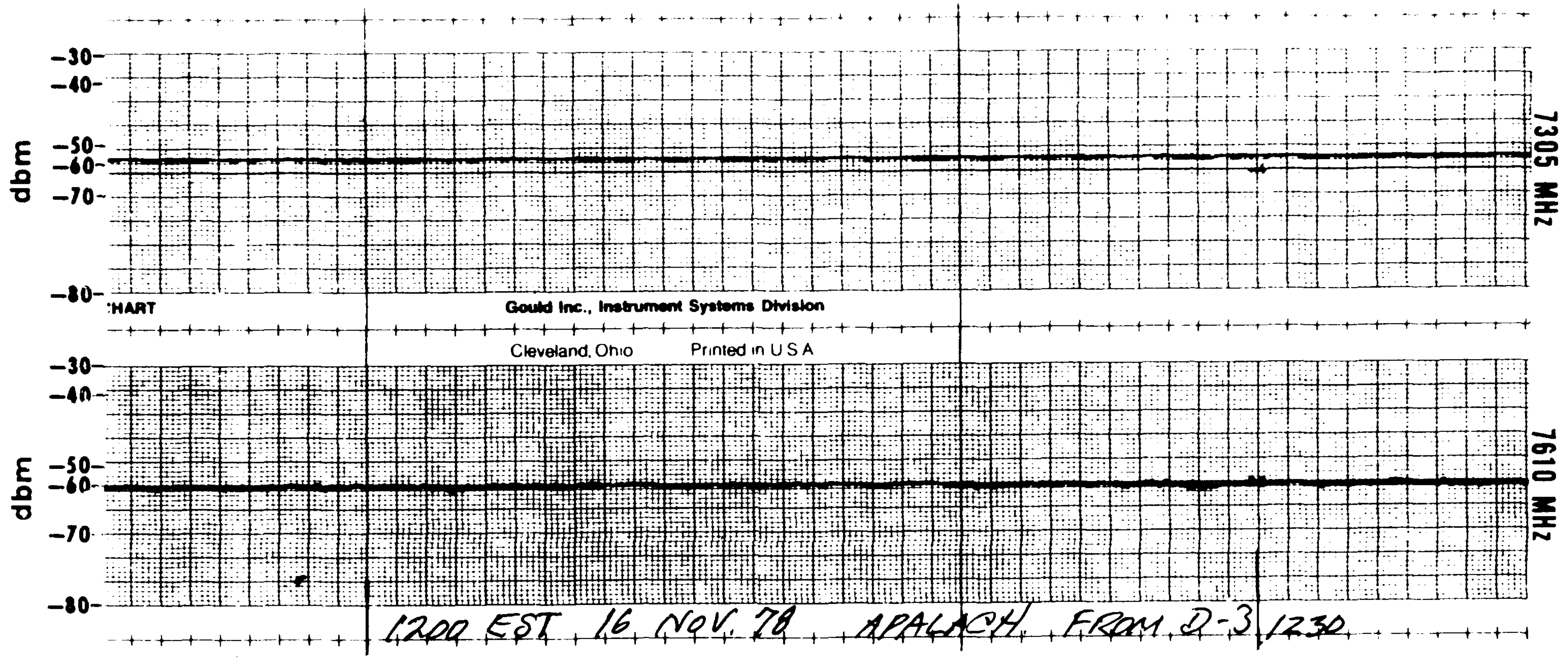


Figure 10-2 Case 10 RSL Strip Chart showing typical stable pattern on both channels of APA received from D3. Times are from 1151 EST to 1239 EST, 16 Nov 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

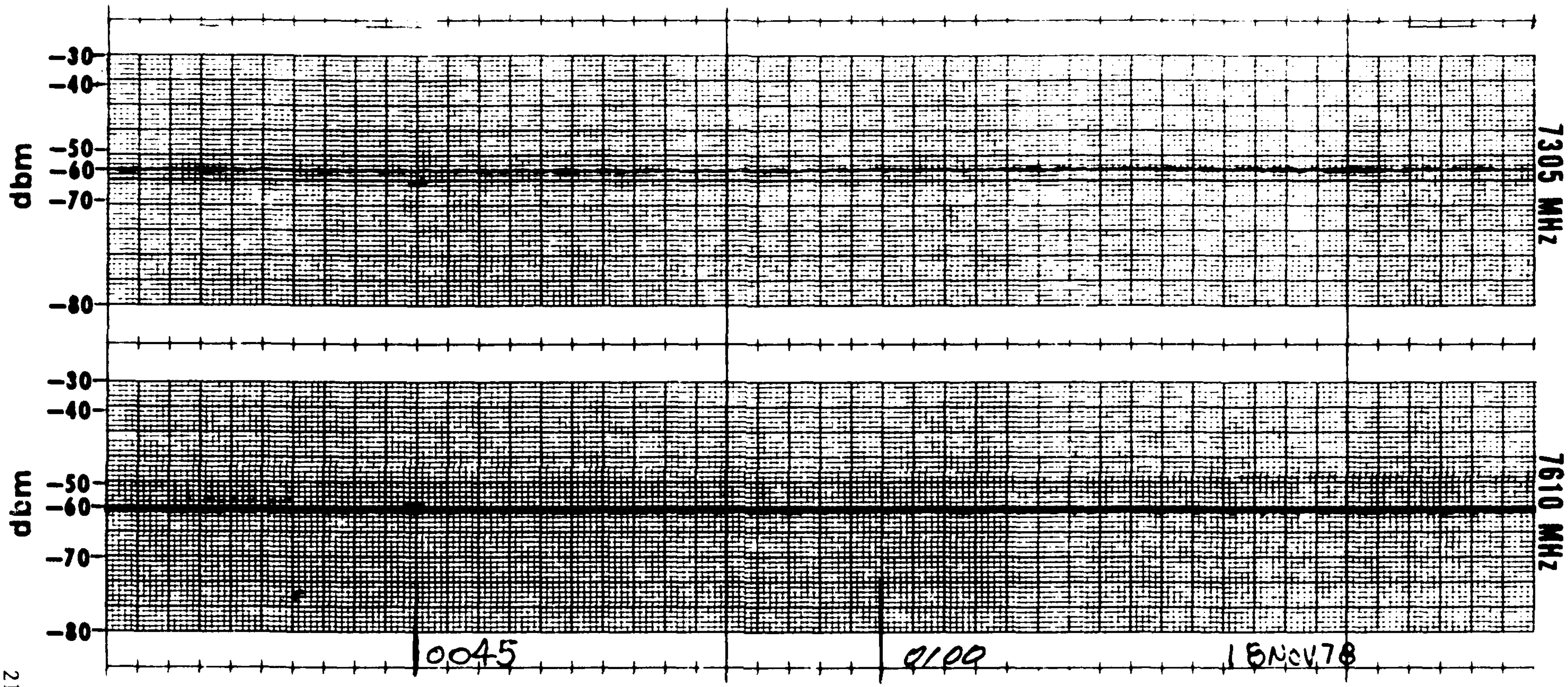


Figure 10-3 Case 10 RSL Strip Chart showing typical stable pattern on both channels of APA received from D3. Times are from 0035 EST to 0121 EST, 18 Nov 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

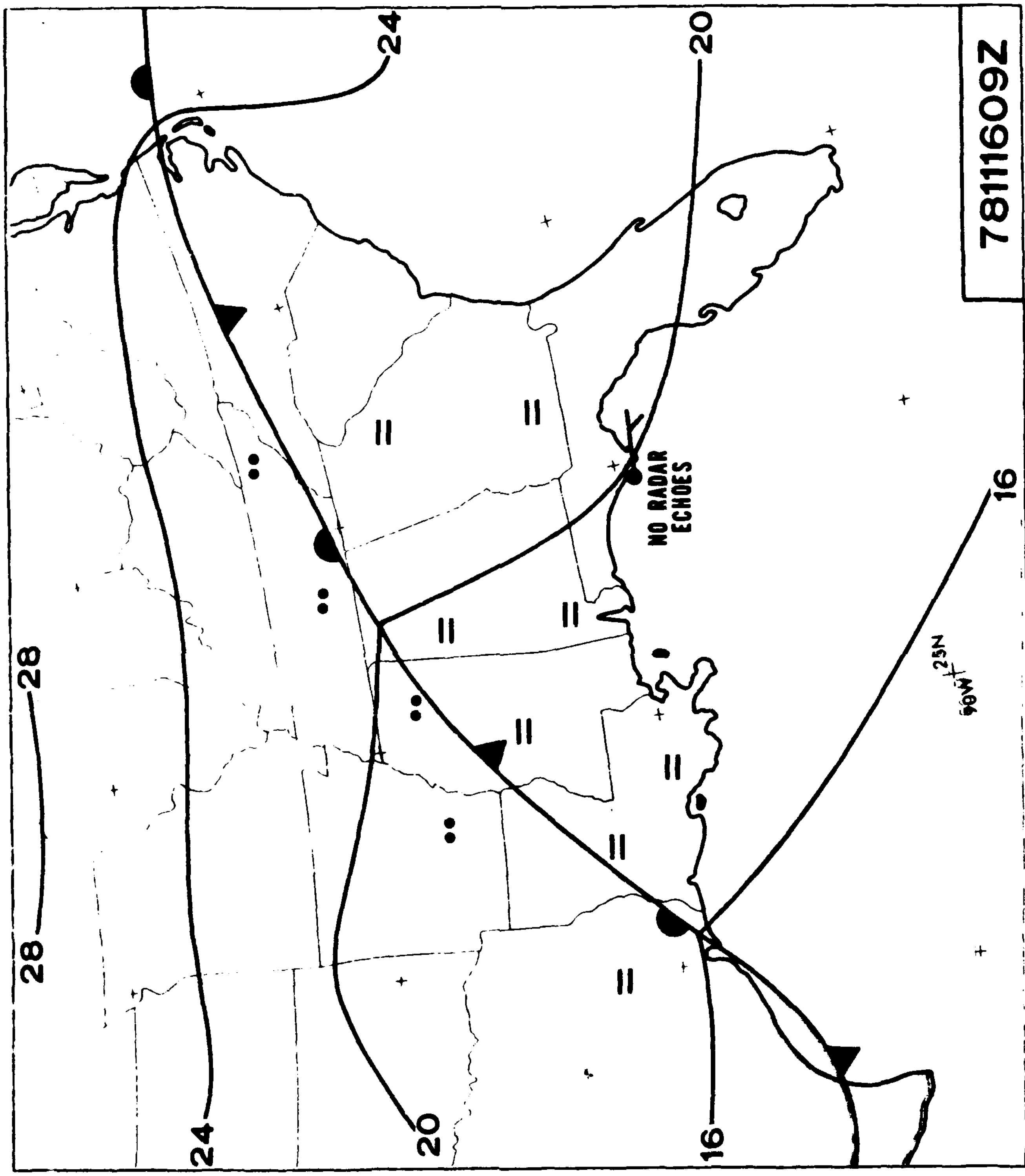


Figure 10-4 78111609Z Synoptic Chart

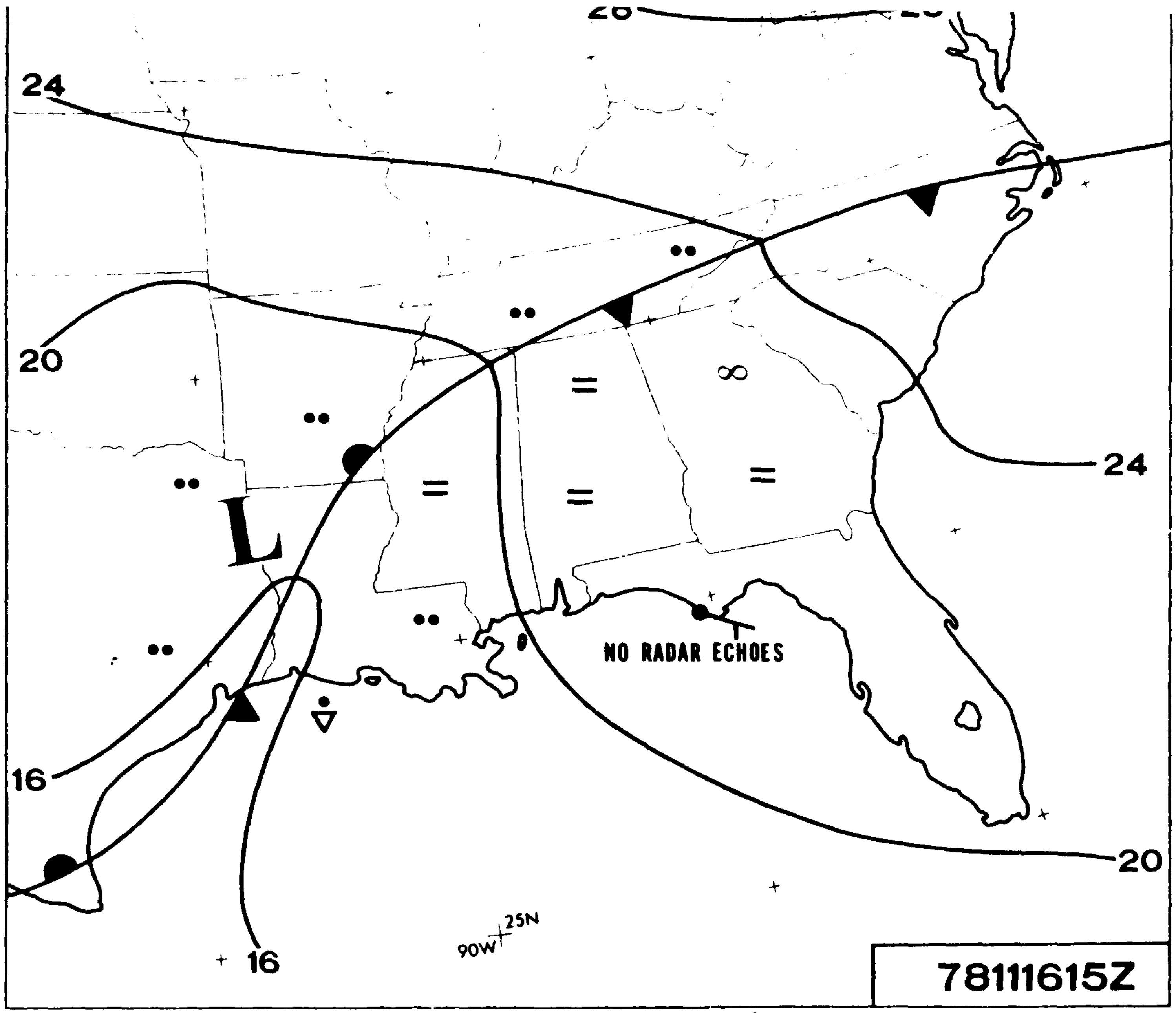


Figure 10-5 78111615Z Synoptic Chart

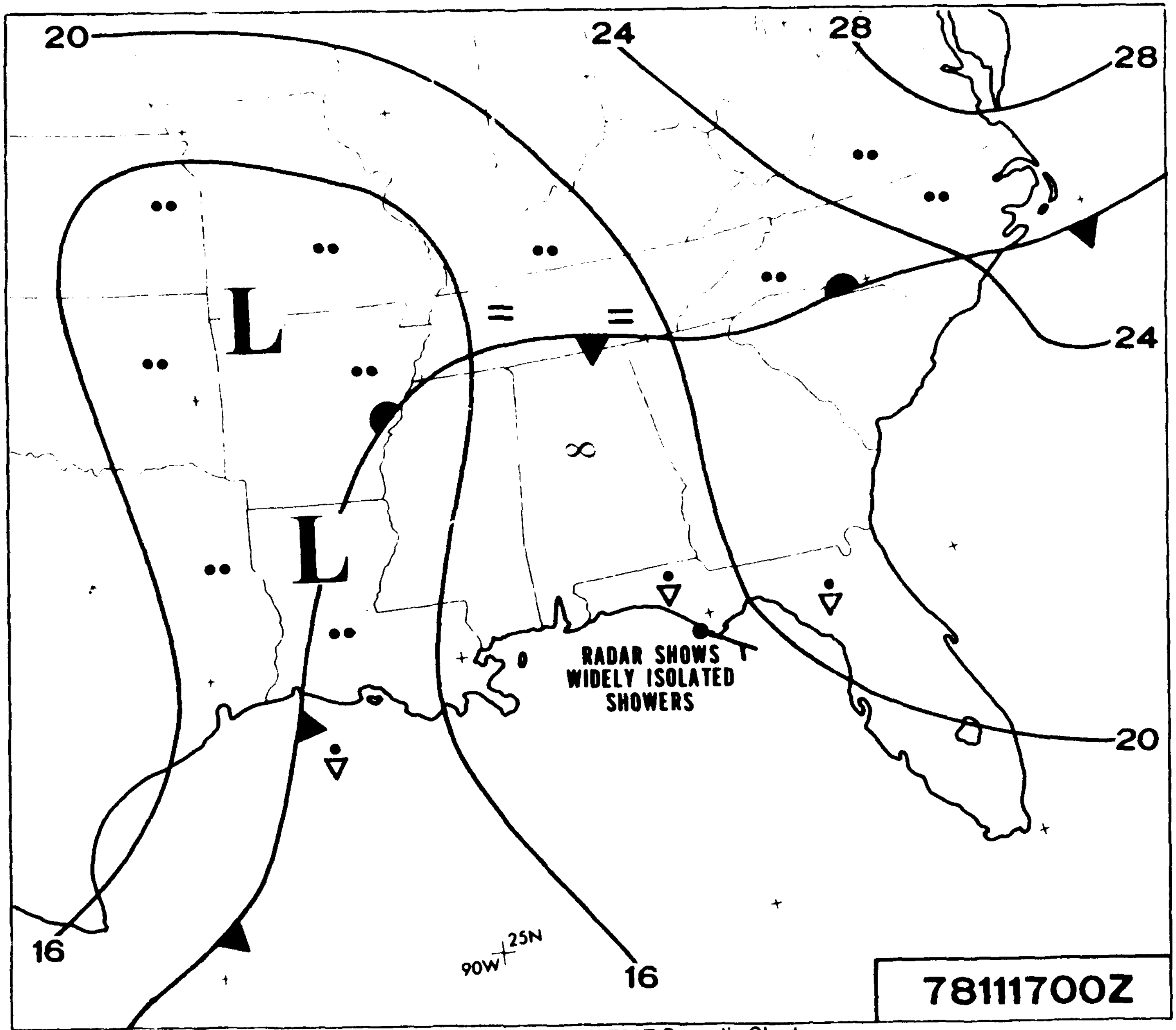


Figure 10-6 78111700Z Synoptic Chart

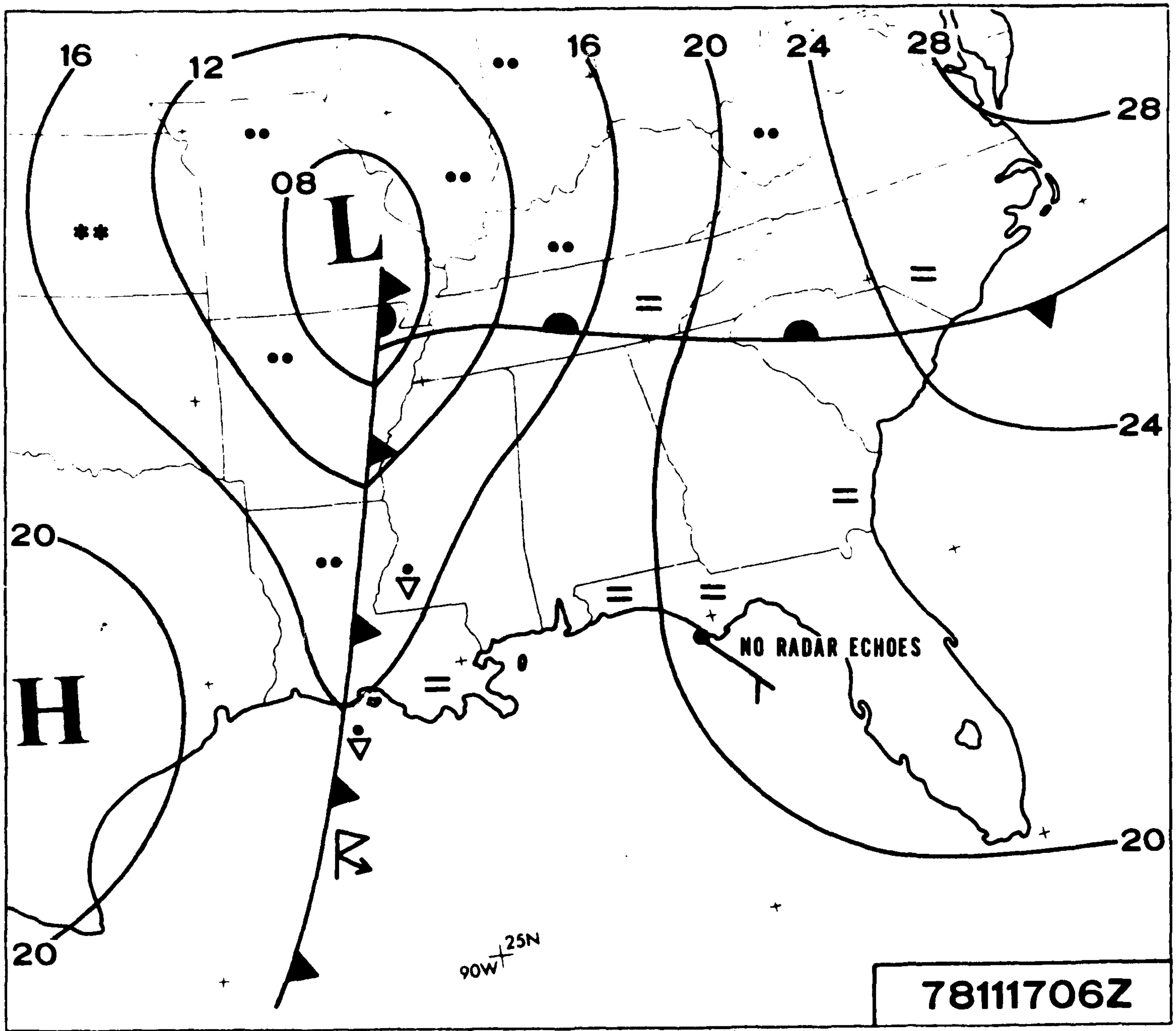


Figure 10-7 78111706Z Synoptic Chart

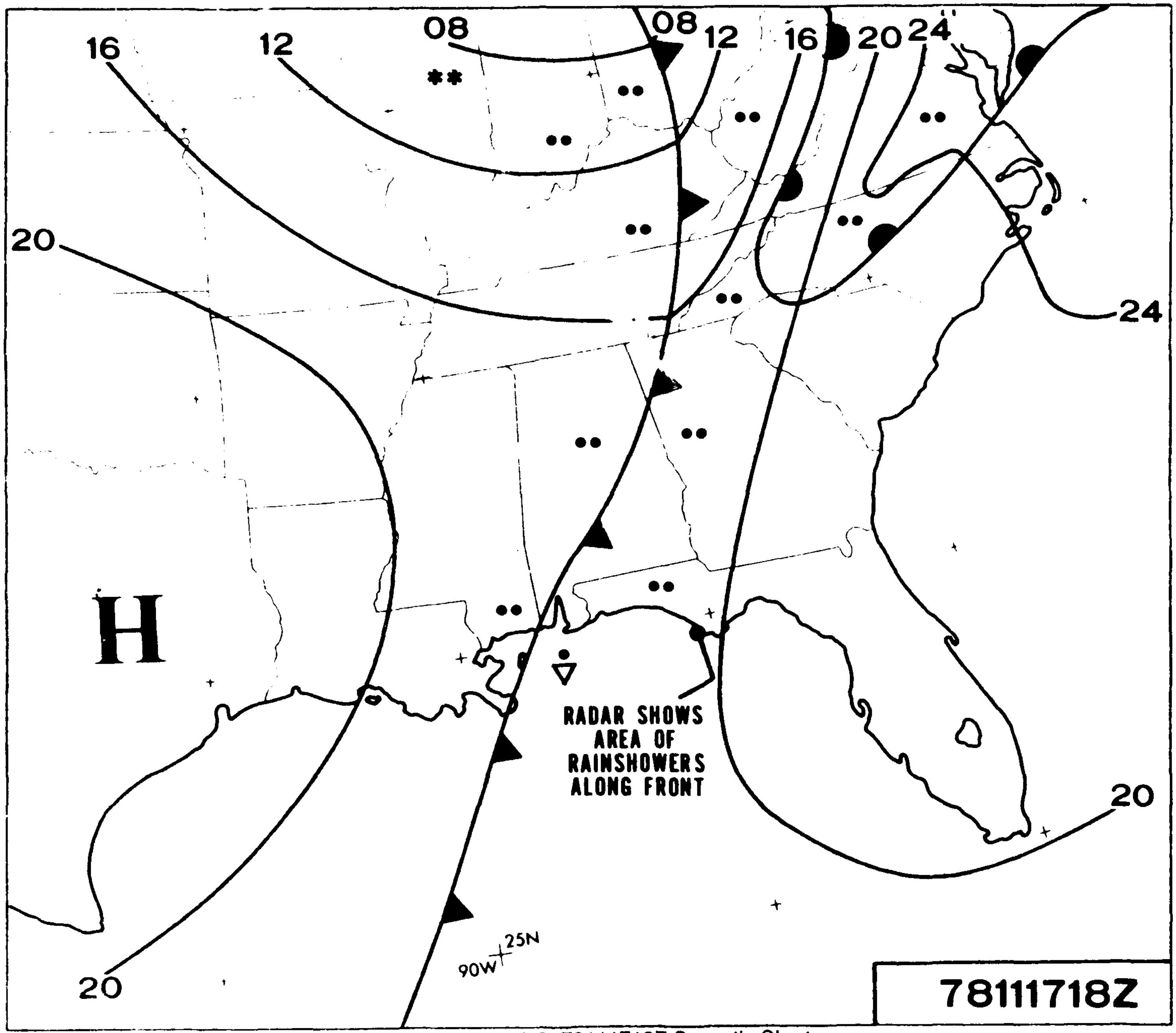


Figure 10-8 78111718Z Synoptic Chart

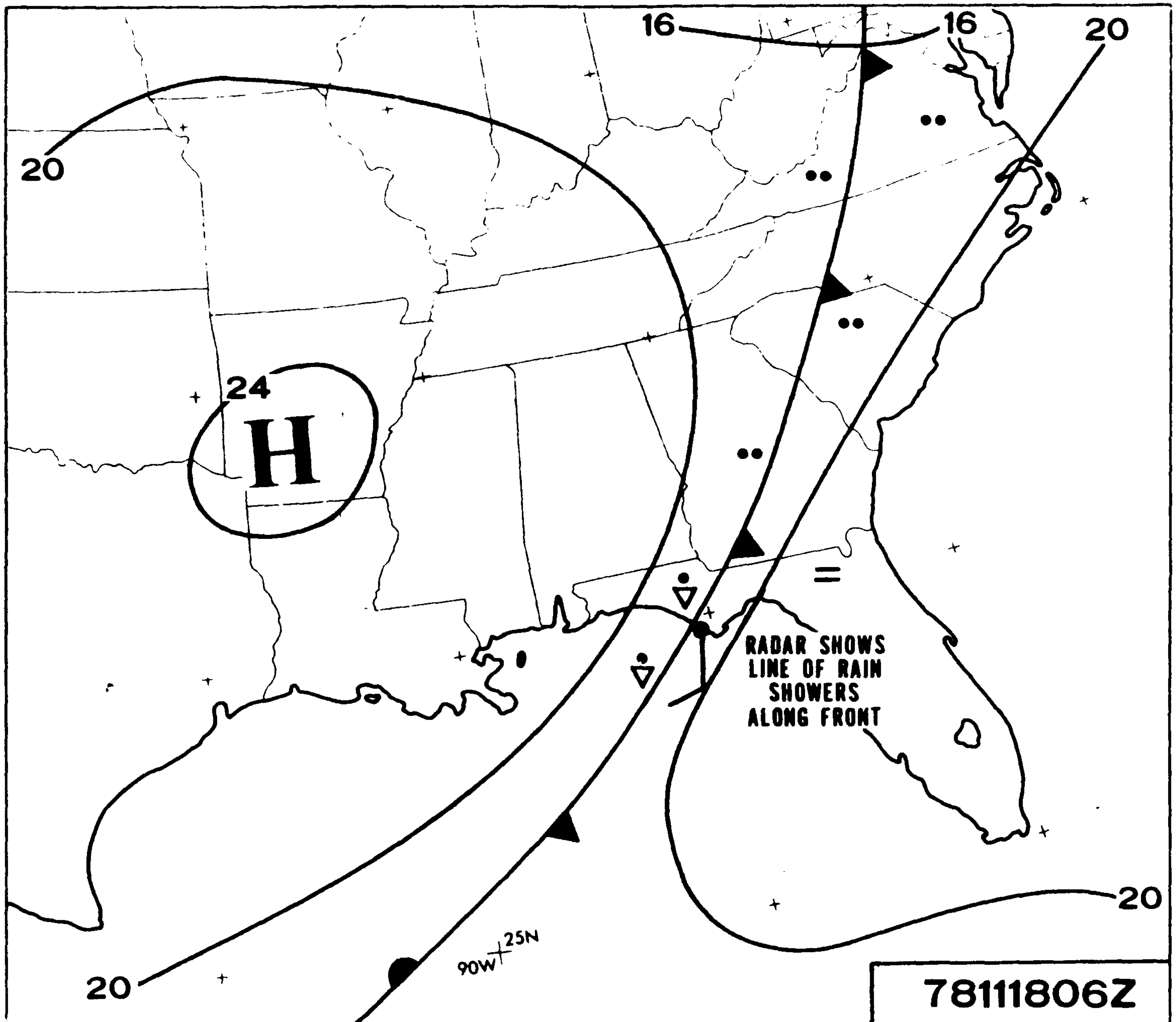


Figure 10-9 78111806Z Synoptic Chart

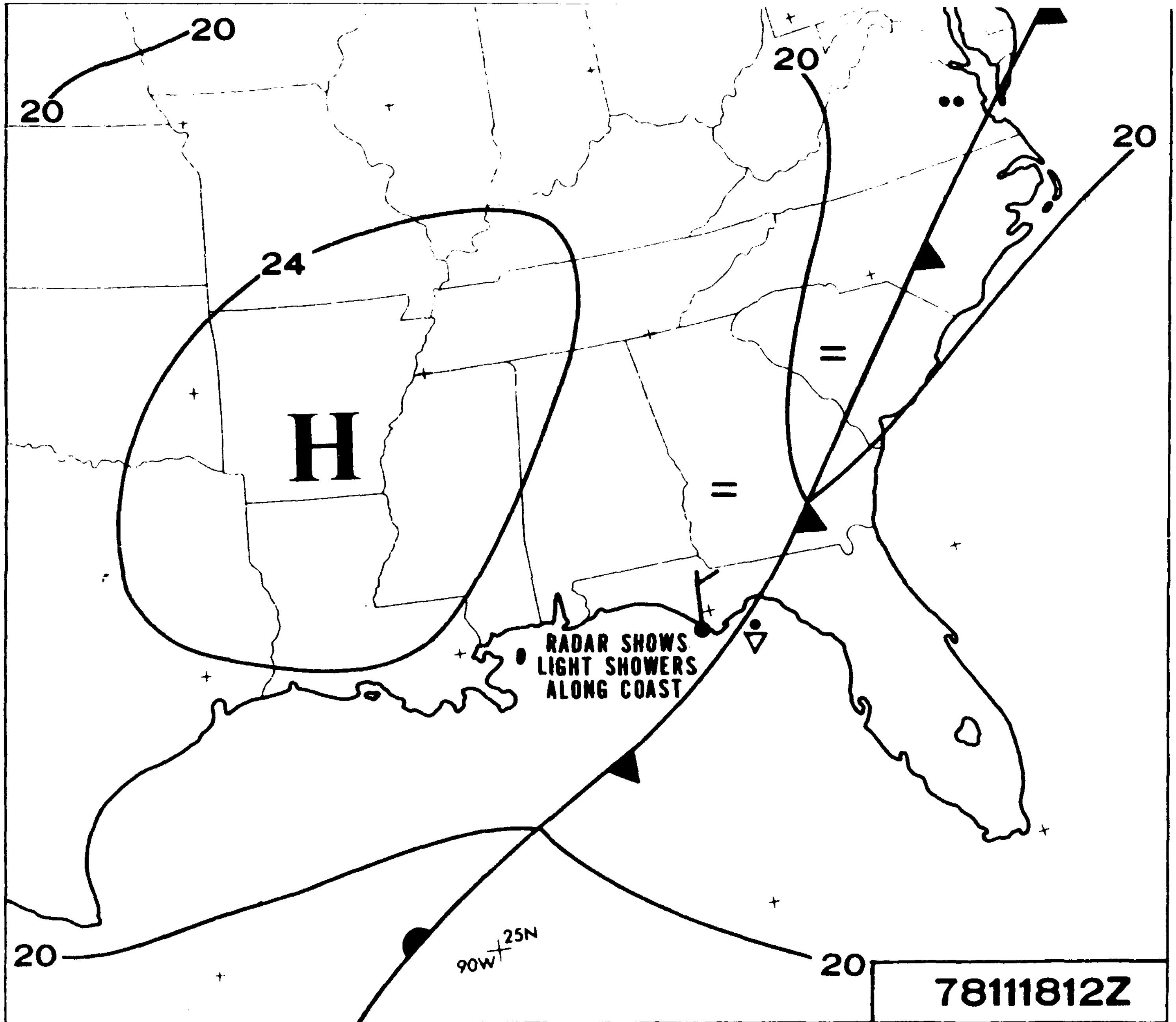


Figure 10-10 78111812Z Synoptic Chart

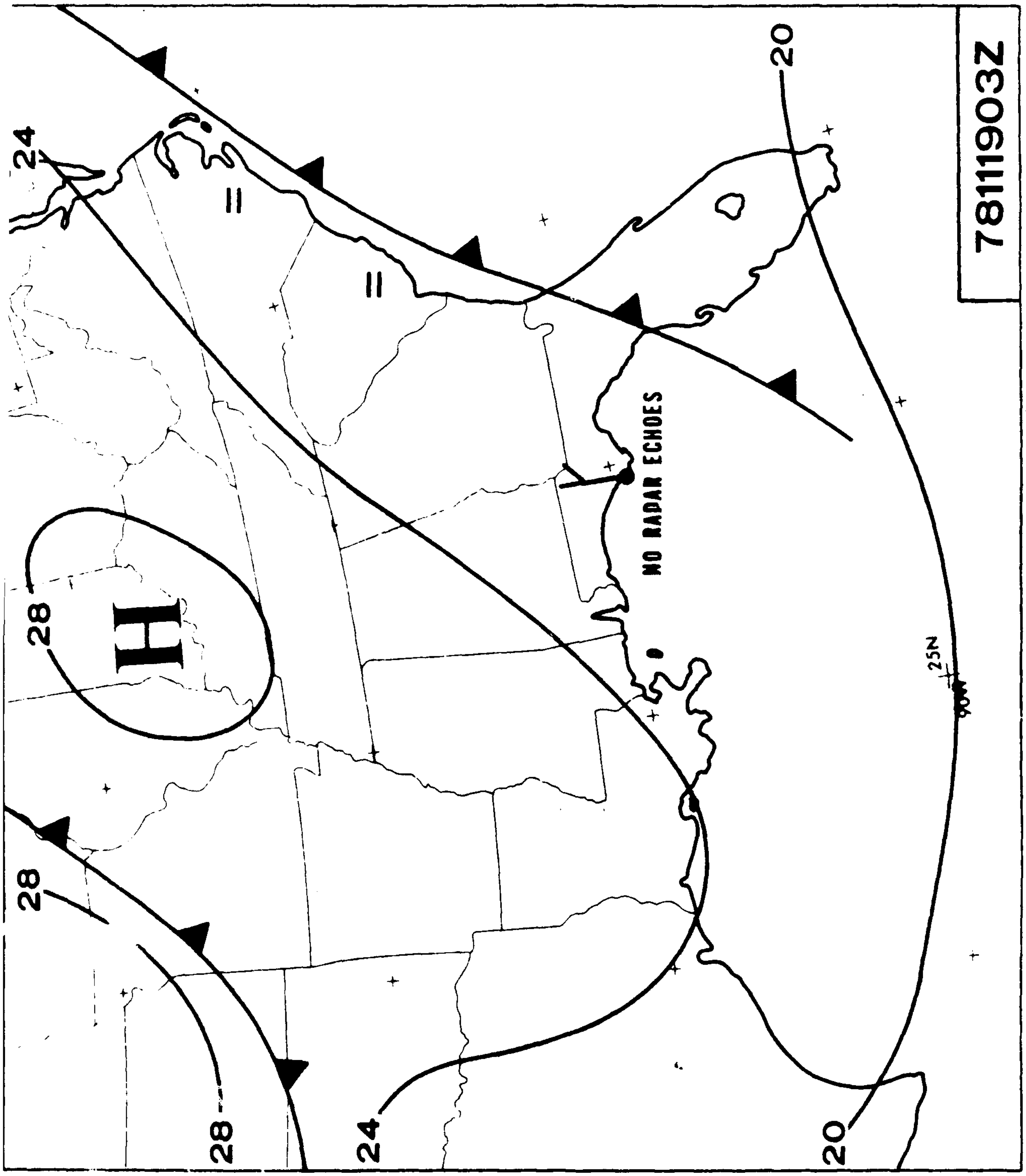


Figure 10-11 78111903Z Synoptic Chart

Table 10-1. Case 10, Apalachicola Surface Weather, 16 Nov 78, 1000Z - 19 Nov 78, 0300Z.

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 16 09	17.2	0.5	120	4	SCT	6	F
12	16.7	0.0	120	3	BKN	5	F
15	23.3	1.6	140	8	BKN	7	None
18	25.0	3.3	150	8	BKN	7	None
11 17 00	21.1	0.0	140	4	BKN	5	H
03	21.1	0.5	140	4	SCT	6	H
06	21.1	0.5	140	4	BKN	5	F
09	21.7	0.6	140	7	OVC	5	F
12	21.7	0.6	150	8	OVC	6	F
15	23.3	1.6	160	10	OVC	7	None
18	24.4	3.3	170	7	OVC	7	None
21	23.3	1.6	150	6	OVC	7	None
11 18 00	22.2	0.5	170	6	SCT	7	None
03	22.2	0.5	180	6	SCT	7	None
06	21.7	0.0	180	3	SCT	7	None
09	20.0	0.0	CALM	CALM	SCT	5	F
12	18.9	0.0	CALM	CALM	BKN	4	F
15	23.9	2.2	350	3	OVC	7	None
18	25.0	3.9	180	5	OVC	7	--
21	25.0	3.3	180	8	BKN	7	None
11 19 00	22.8	1.7	310	7	OVC	7	None
03	18.9	0.0	330	4	SCT	7	None
06	18.3	2.2	40	6	CLR	7	None

Table 10-2. Case 10, Tyndall Surface Weather, 16 Nov 78, 1000Z - 19 Nov 78, 0300Z.

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 16 09	17.8	3.4	CALM	CALM	SCT	7	None
12	17.2	2.8	80	2	SCT	7	None
1318	--	--	100	3	BKN	7	None
1352	--	--	90	5	BKN	4	F
1404	--	--	90	5	BKN	$1\frac{1}{2}$	F
1428	--	--	90	4	OVC	1	F
1500	21.1	2.8	90	4	OVC	2	F
1505	--	--	90	6	BKN	3	F
1531	--	--	90	5	BKN	7	None
1800	26.7	7.3	150	7	SCT	7	None

Table 10-2. Case 10, Tyndall Surface Weather, 16 Nov 78, 1000Z - 19 Nov 78, 0300Z (Cont'd).

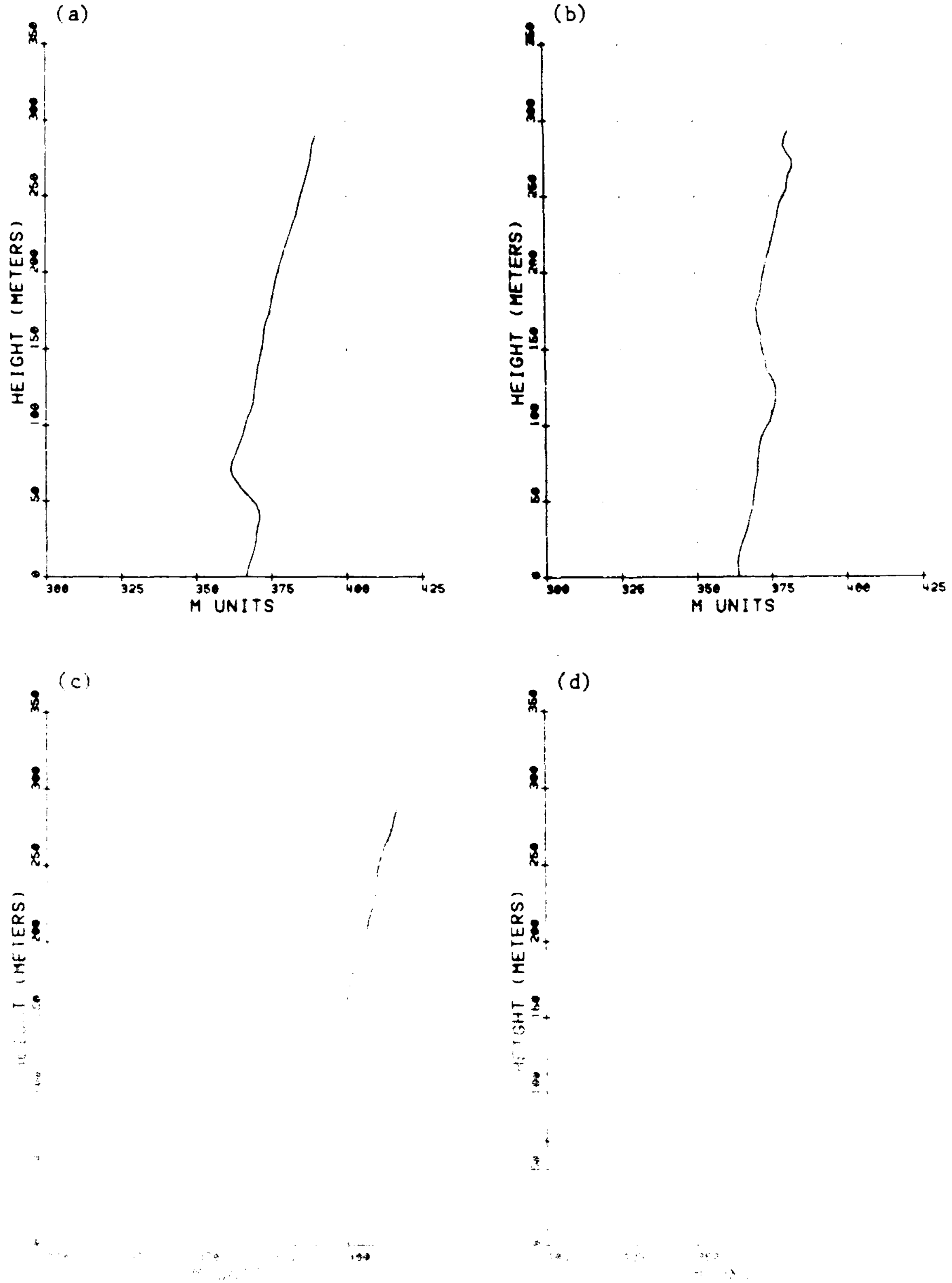
Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 16 21	25.0	6.7	170	8	SCT	10	None
11 17 00	22.2	3.9	150	6	SCT	10	None
0300	20.0	3.3	CALM	CALM	BKN	7	None
0313	--	--	100	6	BKN	4	F
0600	20.6	2.8	110	5	X	$\frac{1}{2}$	F
0751	--	--	100	3	X	$\frac{1}{16}$	F
0900	20.6	2.8	90	4	X	$\frac{1}{16}$	F
1028	--	--	100	4	BKN	2	F
12	20.6	2.8	120	2	BKN	5	F
15	24.4	10.0	150	6	BKN	7	None
18	26.1	6.1	150	11	BKN	7	None
21	25.0	5.6	160	12	BKN	7	None
11 18 00	22.8	3.4	150	9	SCT	7	None
03	22.8	3.4	150	6	BKN	7	None
0600	22.8	3.4	180	5	BKN	7	None
0654	--	--	180	5	BKN	7	None
0753	--	--	190	5	BKN	7	None
0900	22.8	2.8	200	4	OVC	7	None
0944	--	--	3[illegible]0	6	OVC	7	RW-
1108	--	--	20	2	OVC	4	R-
1119	--	--	360	3	OVC	2	RW-
1135	--	--	40	4	OVC	3	R-
1144	--	--	30	2	OVC	5	F
1200	21.1	2.8	10	3	OVC	4	F
1249	--	--	360	4	BKN	7	None
1317	--	--	20	3	BKN	7	None
1350	--	--	340	5	OVC	5	F
1423	--	--	360	4	OVC	5	F
1429	--	--	360	4	OVC	6	F
1500	20.6	3.4	360	4	OVC	6	F
1539	--	--	360	6	OVC	7	None
18	--	--	30	4	BKN	7	None
21	25.6	8.4	310	4	SCT	7	None
11 19 00	20.6	4.5	300	2	SCT	7	None
03	20.0	7.2	360	4	SCT	10	None

Table 10-3. Case 10, Eglin Surface Weather, 16 Nov 78, 1000Z - 19 Nov 78, 0300Z.

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 16 10	18.3	1.1	50	2	SCT	3	F
1200	17.2	0.5	40	2	SCT	2	F
1247	--	--	50	2	SCT	3	F
15	22.8	4.5	60	3	BKN	7	None
18	26.1	6.1	120	8	BKN	7	None
21	25.0	3.3	130	12	BKN	7	None
11 17 0000	22.8	0.6	130	9	OVC	6	F
0150	22.8	1.1	130	8	BKN	7	None
0208	--	--	130	8	BKN	7	None
0600	22.8	0.6	110	6	OVC	7	None
0616	--	--	120	8	BKN	7	None
0629	--	--	110	6	OVC	7	None
0645	--	--	120	6	OVC	7	None
0740	--	--	110	6	OVC	7	None
0900	22.8	0.6	120	7	OVC	7	None
0907	--	--	130	8	BKN	7	None
0921	--	--	130	9	BKN	7	None
0946	--	--	140	9	BKN	7	None
1030	--	--	130	8	OVC	7	None
1114	--	--	140	8	OVC	7	None
1200	22.8	0.6	140	8	BKN	7	None
1205	--	--	140	8	BKN	7	None
1250	--	--	140	8	OVC	7	None
1346	--	--	130	8	BKN	7	None
15	24.4	1.6	140	12	BKN	7	None
18	26.1	3.3	170	12	BKN	7	None
2100	26.1	3.3	160	15	BKN	7	None
2111	--	--	160	16	BKN	7	None
2152	--	--	160	2	BKN	7	None
11 18 0000	23.9	1.1	160	10	OVC	7	None
0247	--	--	300	4	OVC	6	RW-
0300	23.3	2.7	270	2	BKN	4	F
0309	--	--	240	2	BKN	5	F
0336	--	--	CALM	CALM	BKN	7	None
0420	--	--	320	2	BKN	8	None
06	21.7	1.1	350	4	BKN	8	None
0749	--	--	350	3	OVC	12	None
0820	--	--	360	5	OVC	12	None
09	18.9	1.7	360	5	BKN	16	None
1200	16.7	1.7	360	8	BKN	12	None
1240	--	--	360	8	BKN	12	None
1305	--	--	360	7	SCT	12	None
1430	--	--	360	8	BKN	7	None

Table 10-3. Case 10, Eglin Surface Weather, 16 Nov 78, 1000Z - 19 Nov 78, 0300Z (Cont'd).

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 18 15	17.2	2.2	360	8	BKN	7	None
18	23.9	7.8	350	6	BKN	7	None
21	25.0	9.4	340	5	BKN	7	None
11 19 00	20.0	5.6	340	2	SCT	15	None
03	16.7	6.6	360	6	SCT	15	None


(a)
HEIGHT (METERS)
M UNITS
0
50
100
150
200
250
300
350
300
325
350
375
400
425
(b)
HEIGHT (METERS)
M UNITS
(c)
(METERS)
(d)
HEIGHT (METERS)

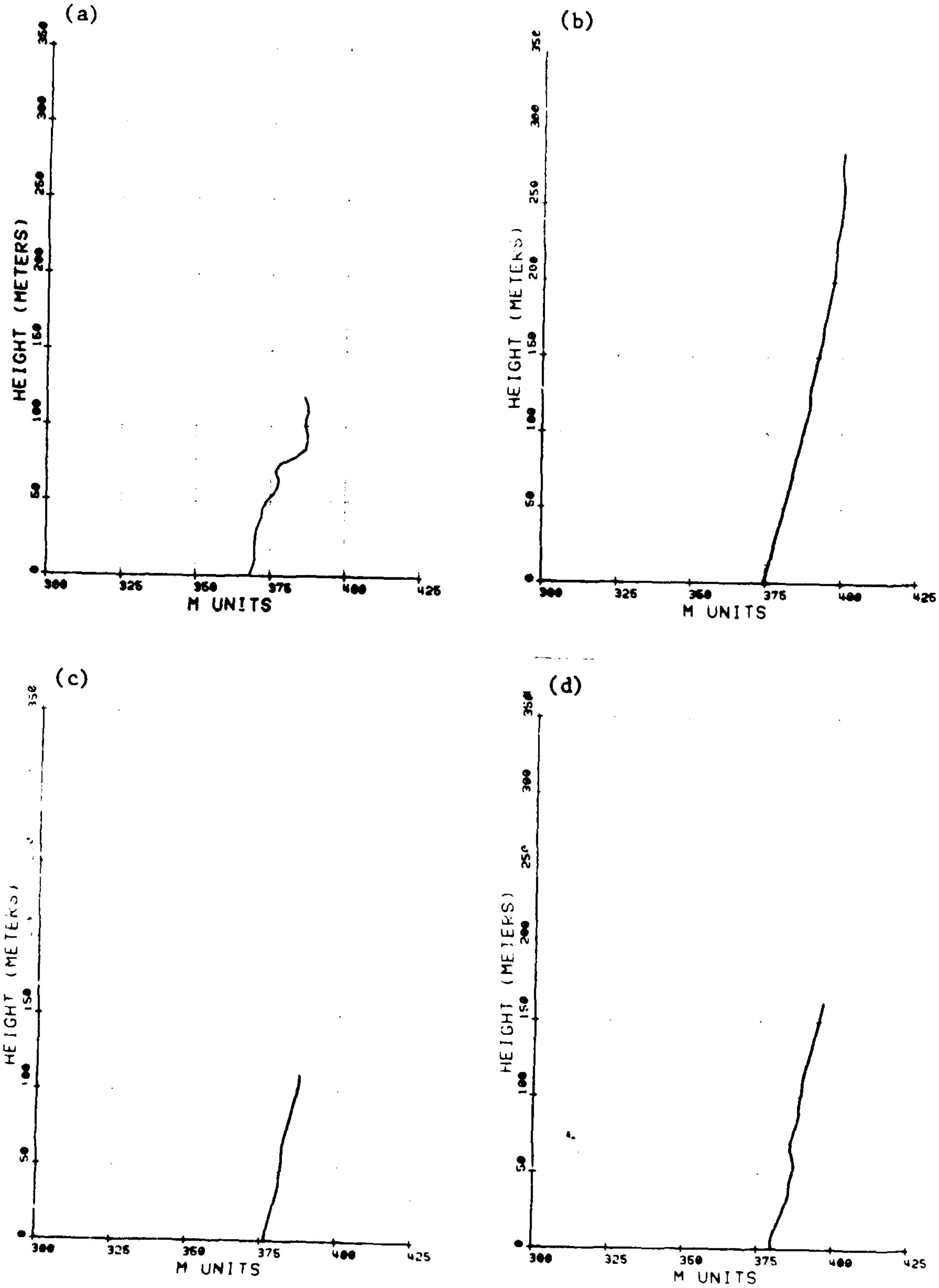


Figure 10-13 Case 10 M-Profiles: a. Cape San Blas, 17 Nov 78, 1000Z; b. Cape San Blas, 17 Nov 78, 1100Z; c. Cape San Blas, 17 Nov 78, 1400Z; d. Cape San Blas, 17 Nov 78, 1600Z.

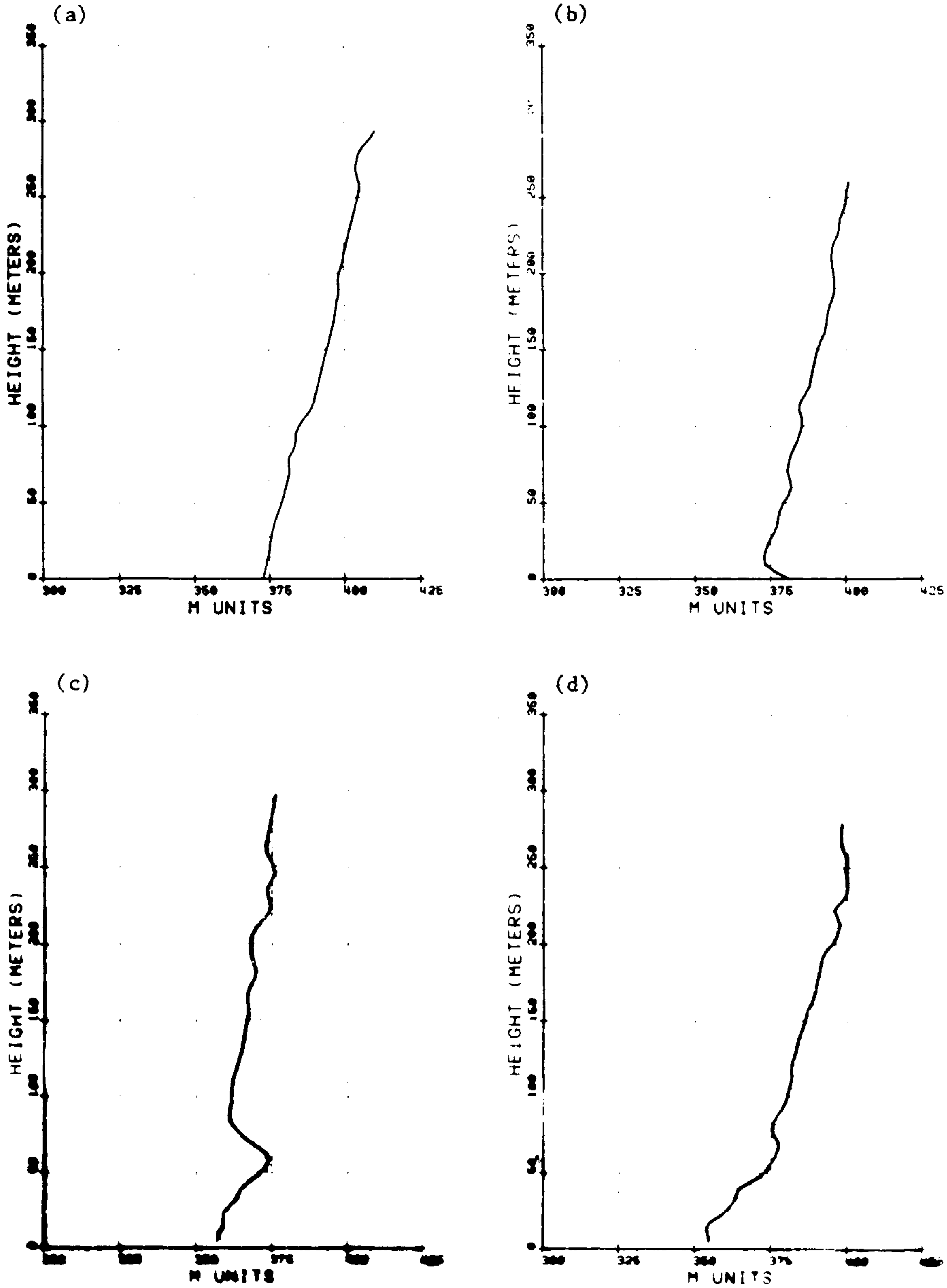


Figure 10-14 Case 10 M-Profiles: a. Cape San Blas, 18 Nov 78, 1[illegible]00Z; b. Cape San Blas, 18 Nov 78, 1600Z; c. Apalachicola, 16 Nov 78, 0800Z; d. Apalachicola, 16 Nov 78, 1000Z.

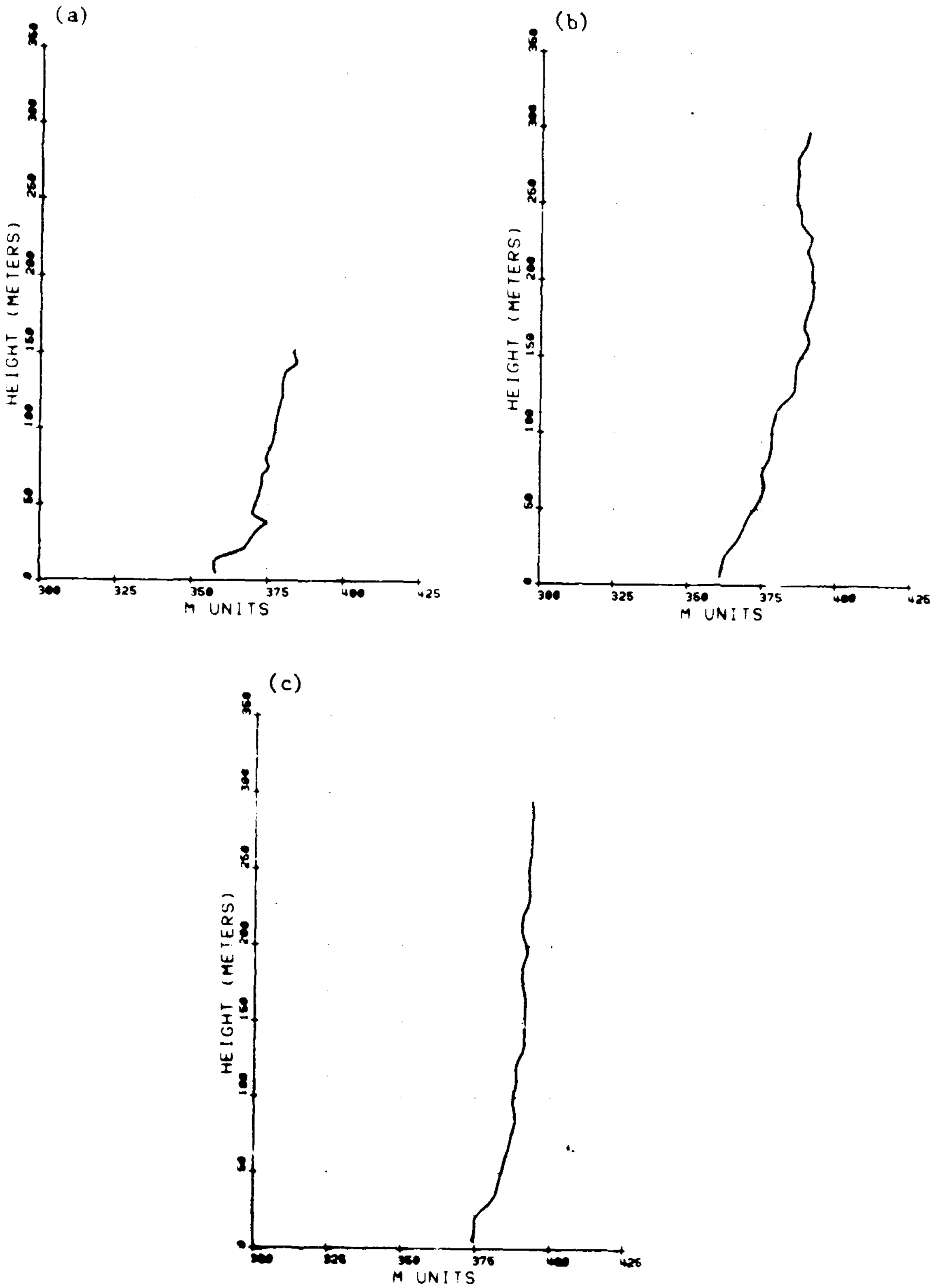


Figure 10-15 Case 10 M-Profiles: a. Apalachicola, 16 Nov 78, 1200Z; b. Apalachicola, 17 Nov 78, 0400Z; c. Apalachicola, 17 Nov 78, 1200Z.

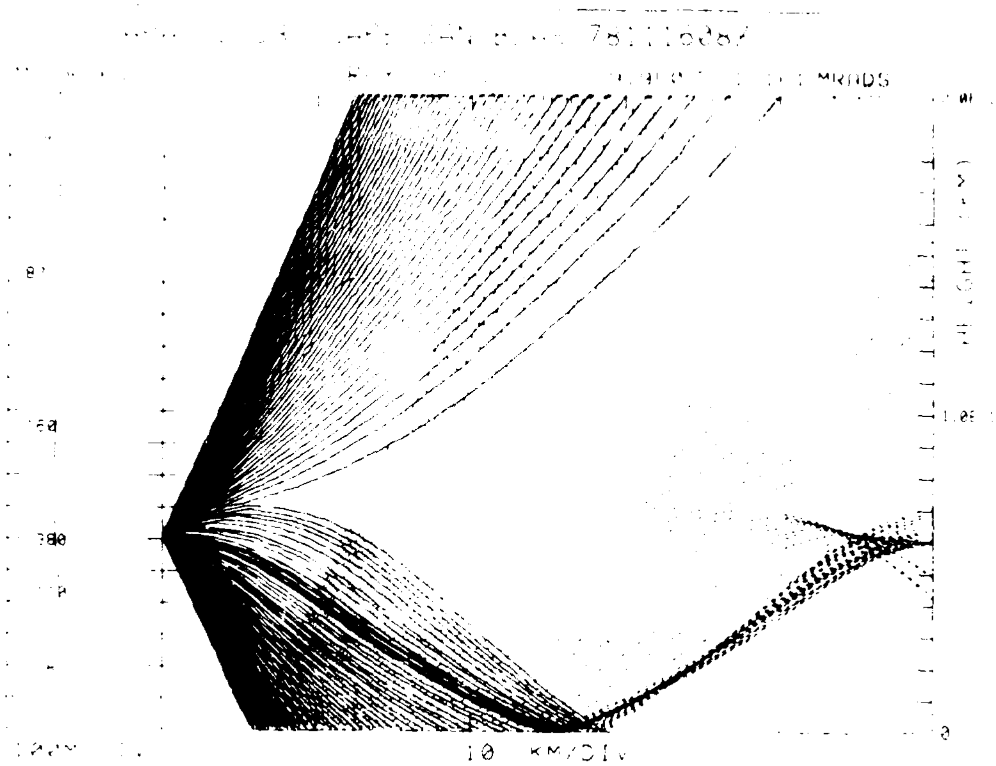


Figure 10-16. Case 10 Raytrace, APA to D3, Cape San Blas 16 Nov 78, 0800Z, Transmitter Height 61.0 m.

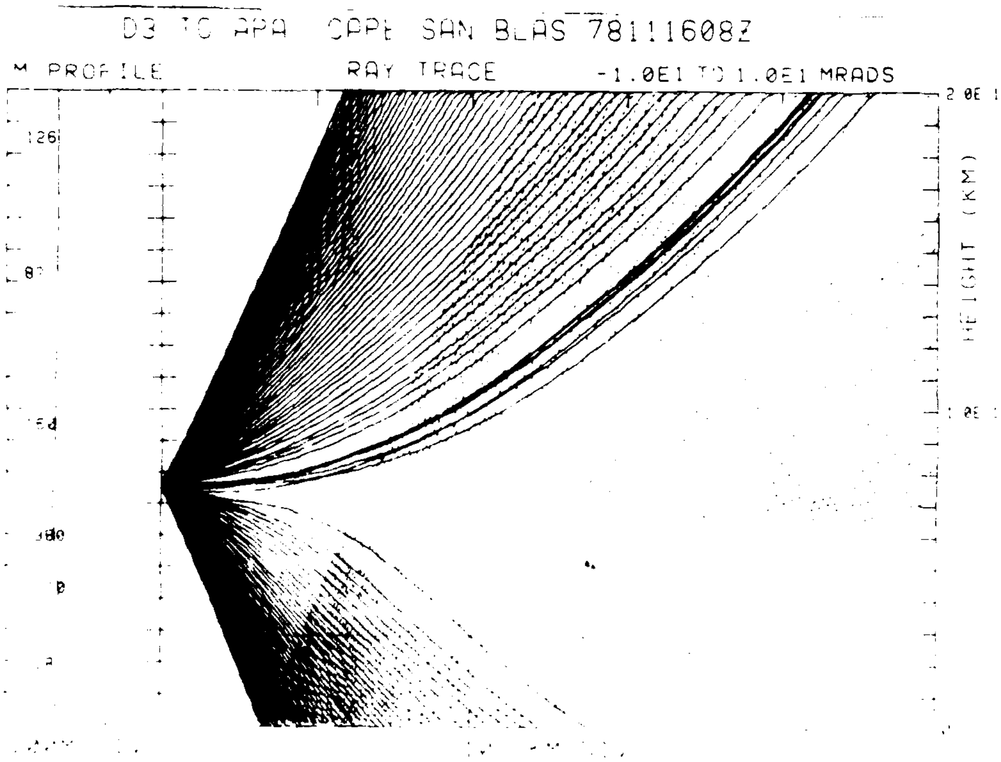


Figure 10-17. Case 10 Raytrace, D3 to APA, Cape San Blas 16 Nov 78, 0800Z, Transmitter Height 76.2 m.

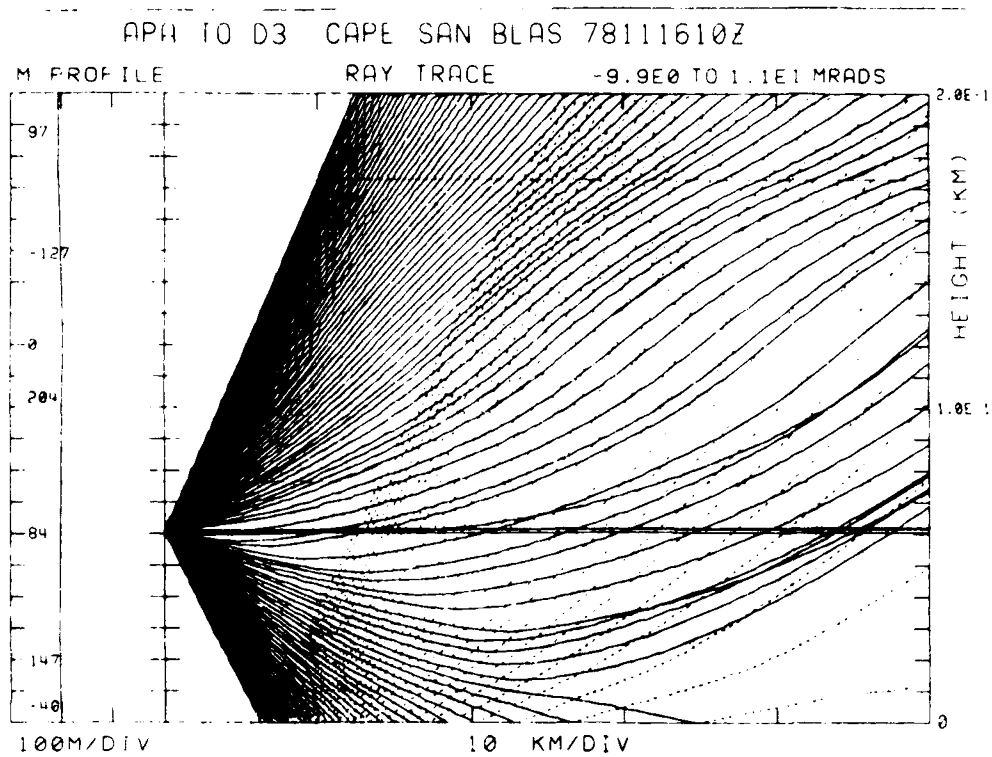


Figure 10-18. Case 10 Raytrace, APA to D3, Cape San Blas 16 Nov 78, 1000Z, Transmitter Height 61.0 m.

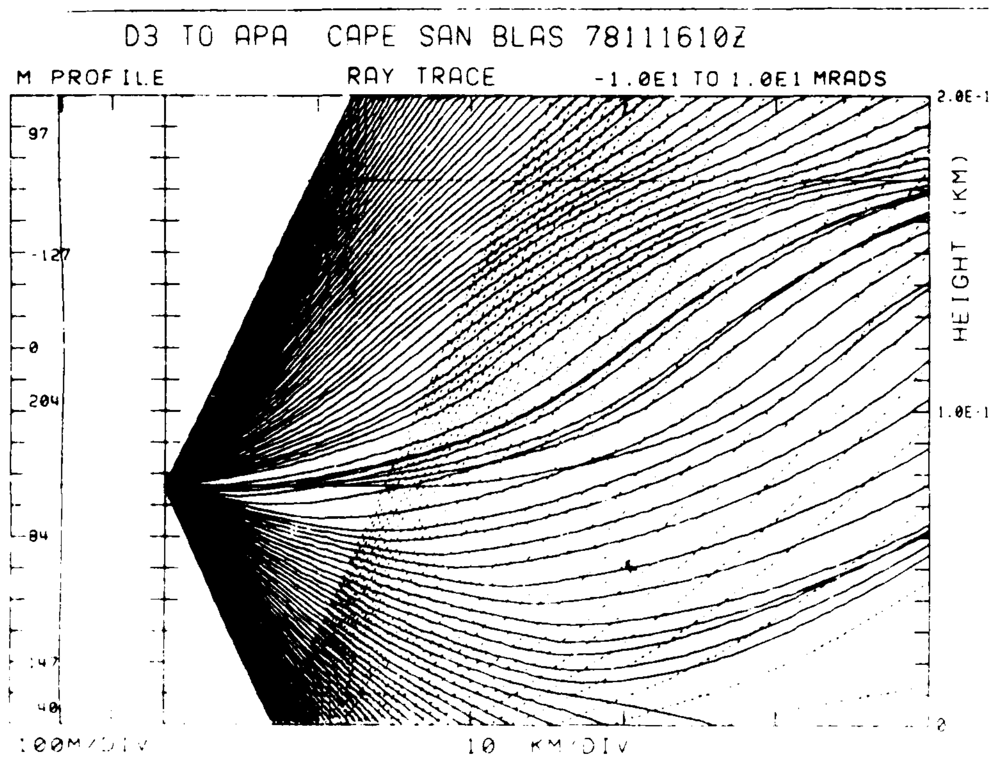


Figure 10-19. Case 10 Raytrace, D3 to APA, Cape San Blas 16 Nov 78, 1000Z, Transmitter Height 76.2 m.

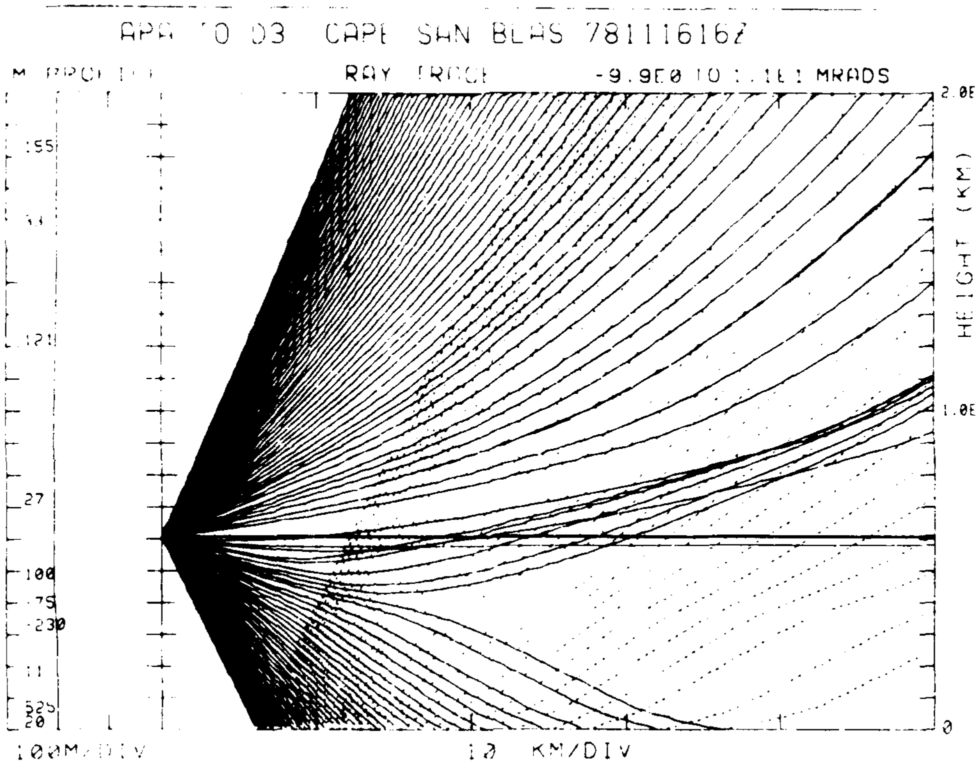


Figure 10-20. Case 10 Raytrace, APA to D3, Cape San Blas 16 Nov 78, 1600Z, Transmitter Height 61.0 m.

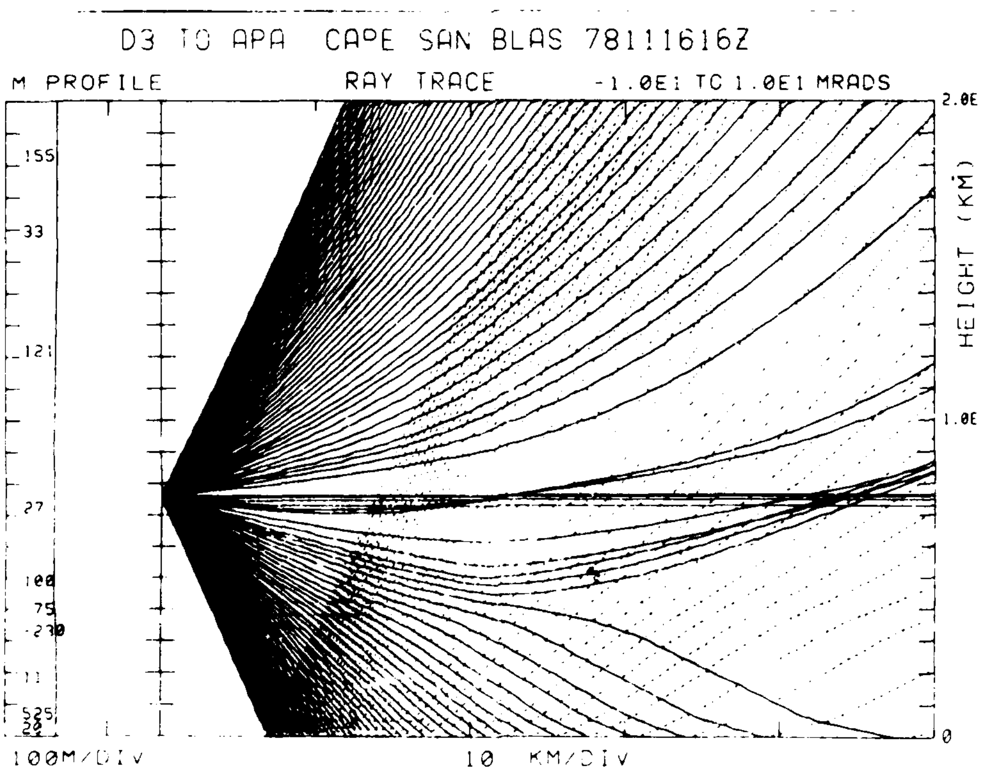


Figure 10-21. Case 10 Raytrace, D3 to APA, Cape San Blas 16 Nov 78, 1600Z, Transmitter Height 76.2 m.

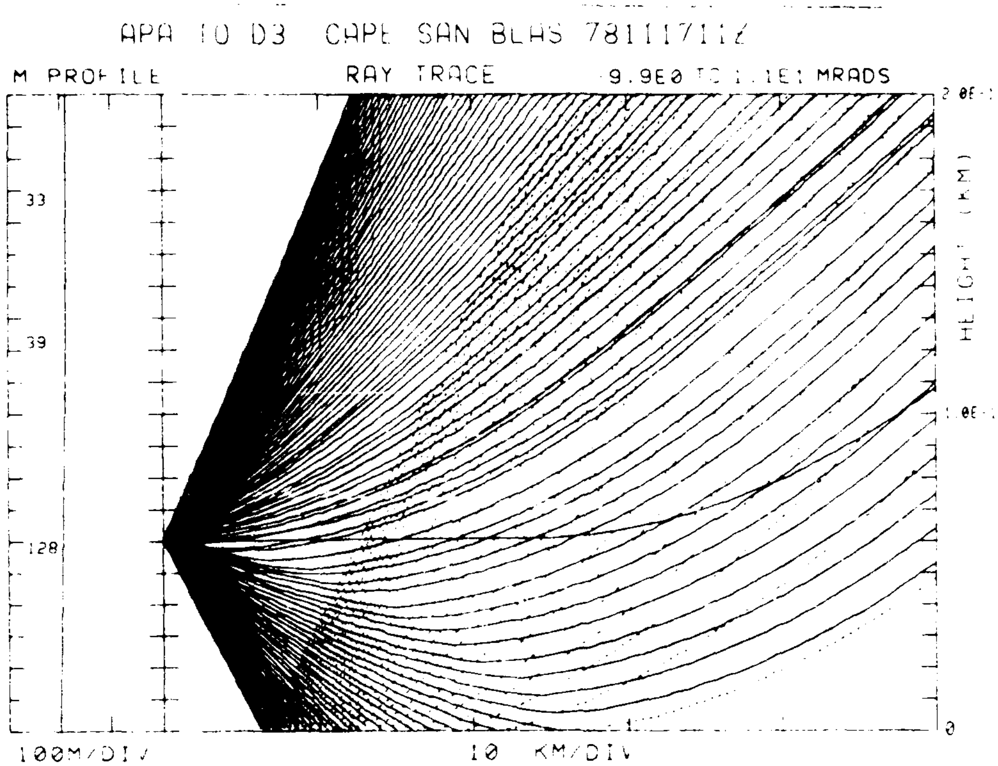


Figure 10-22. Case 10 Raytrace, APA to D3, Cape San Blas 17 Nov 78, 1100Z, Transmitter Height 61.0 m.

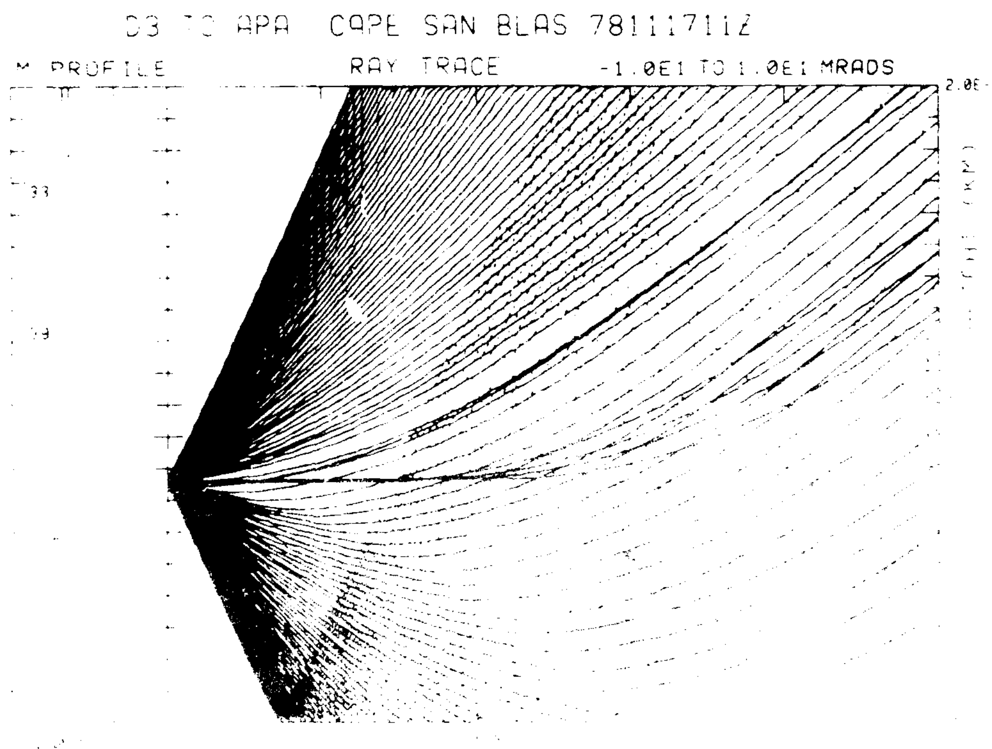


Figure 10-23. Case 10 Raytrace, [illegible] APA [illegible]
[illegible] Nov 78, [illegible] Transmitter [illegible]

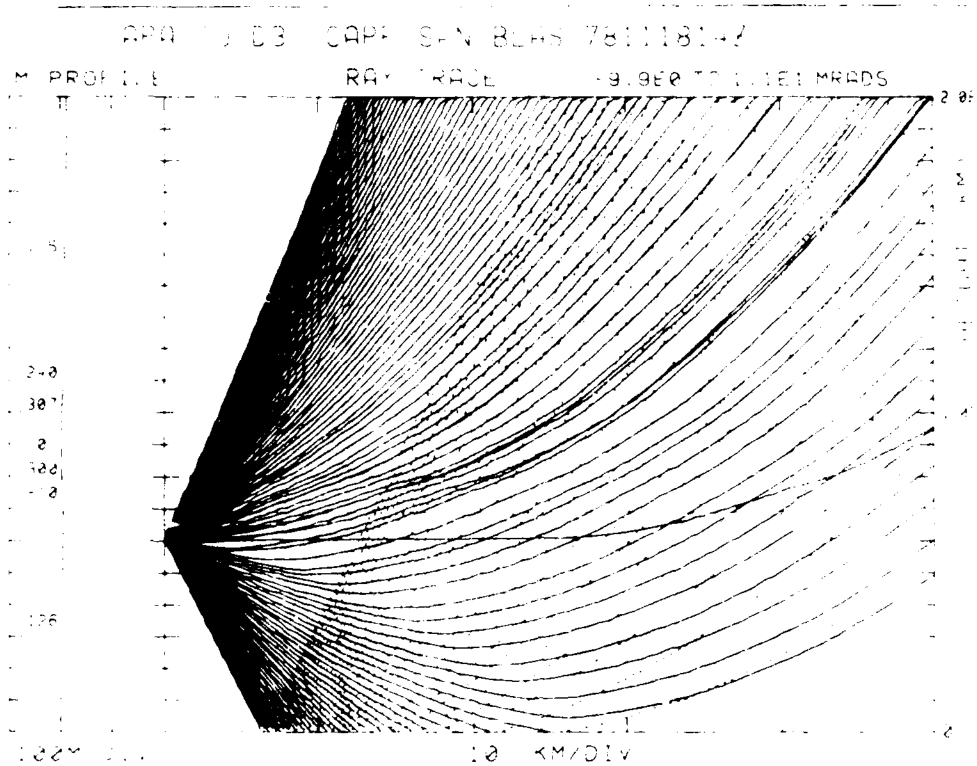


Figure 10-24. Case 10 Raytrace, APA to D3, Cape San Blas 18 Nov 78, 1400Z, Transmitter Height 61.0 m.

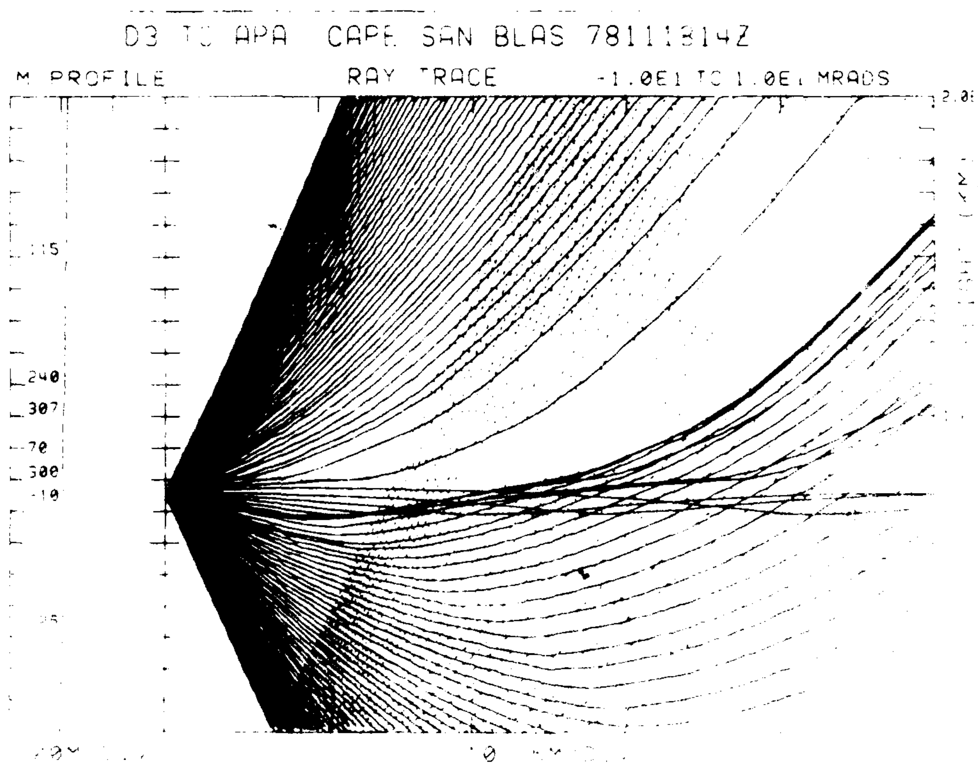


Figure 10-25. Case 10 Raytrace, D3 to APA, Cape San Blas 18 Nov 78, 1400Z, Transmitter Height 76.2 m.

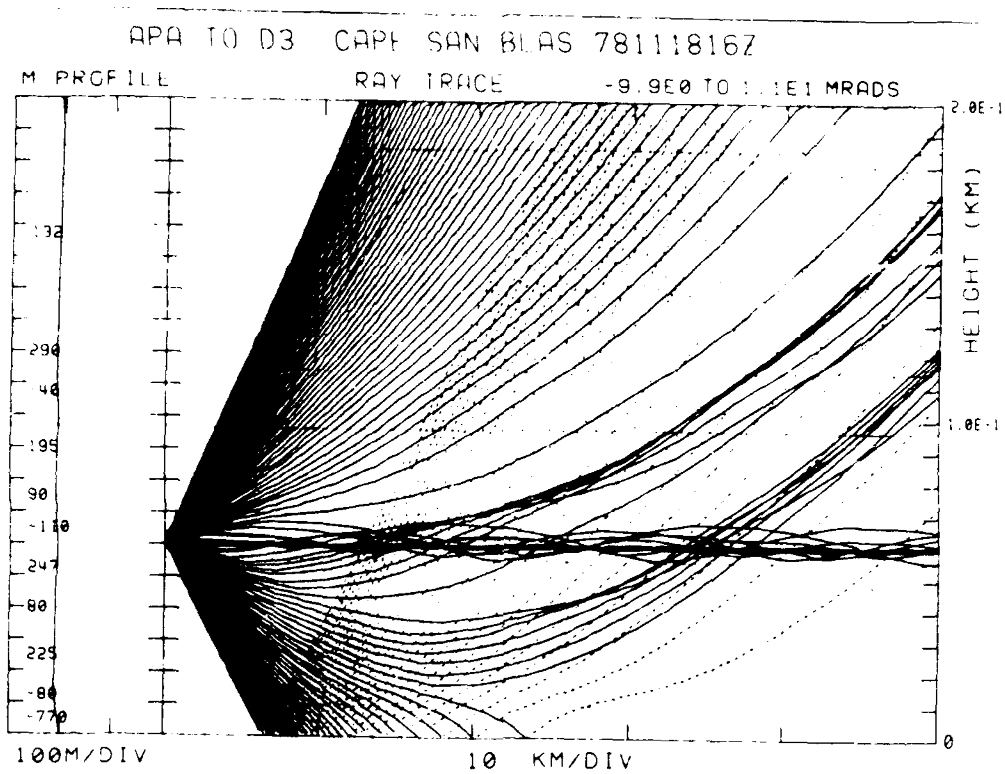


Figure 10-26. Case 10 Raytrace, APA to D3, Cape San Blas 18 Nov 78, 1600Z, Transmitter Height 61.0 m.

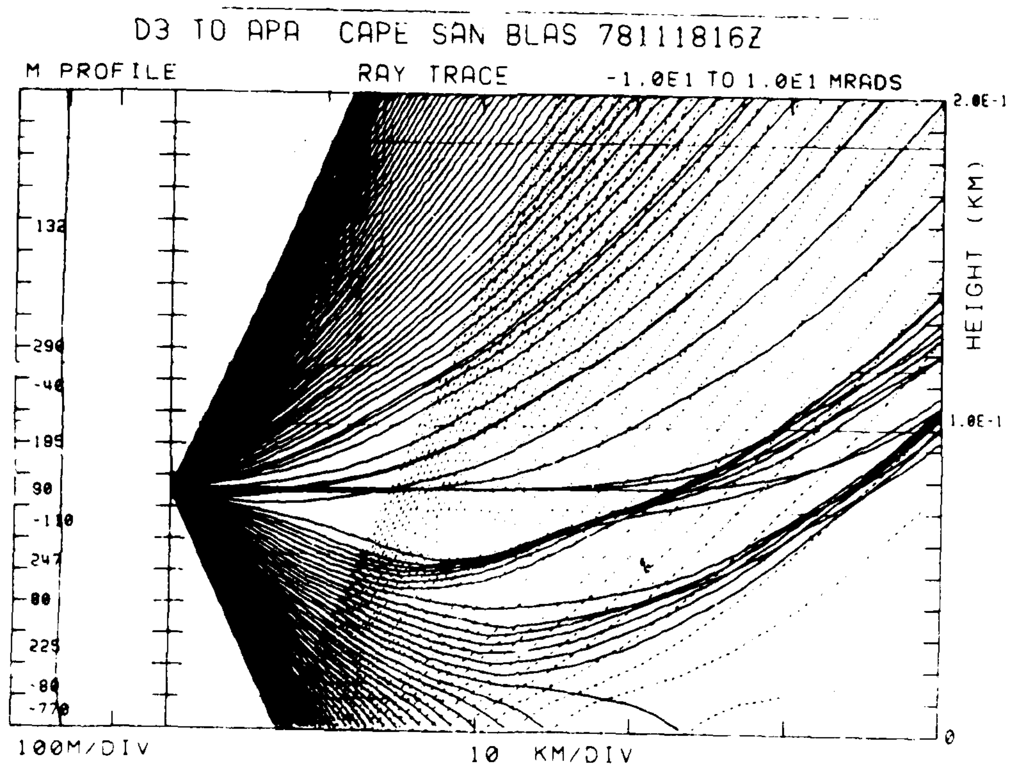


Figure 10-27. Case 10 Raytrace, D3 to APA, Cape San Blas 18 Nov 78, 1600Z, Transmitter Height 76.2 m.

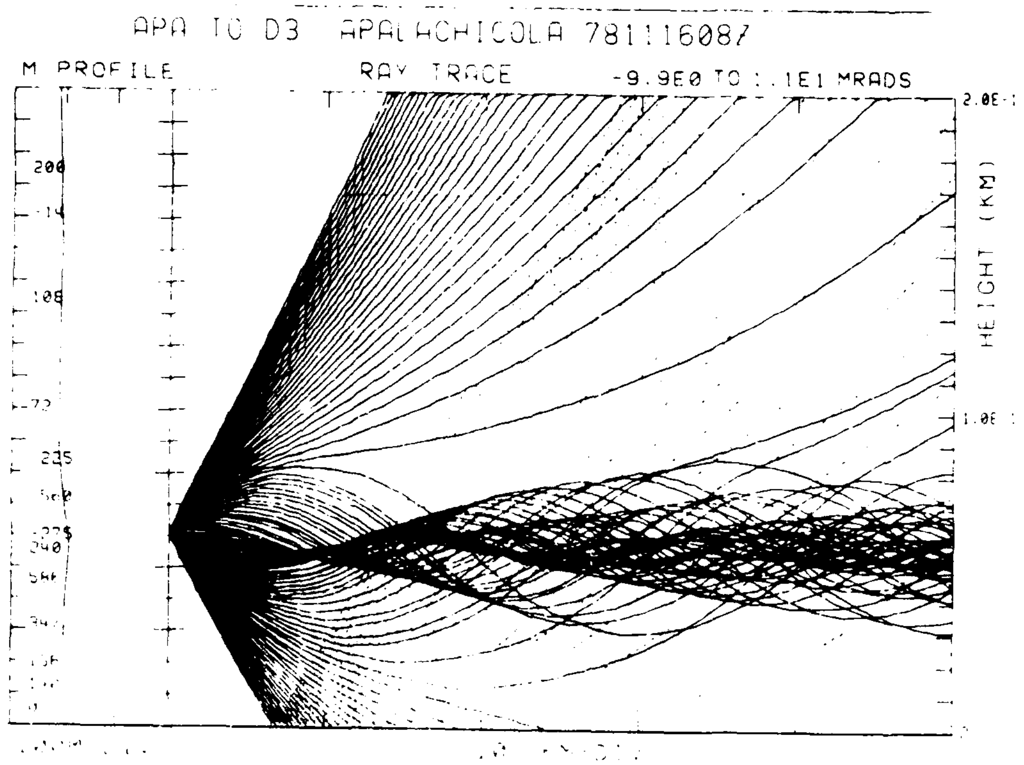


Figure 10-28. Case 10 Raytrace, APA to D3, Apalachicola 16 Nov 78, 0800Z, Transmitter Height 61.0 m.

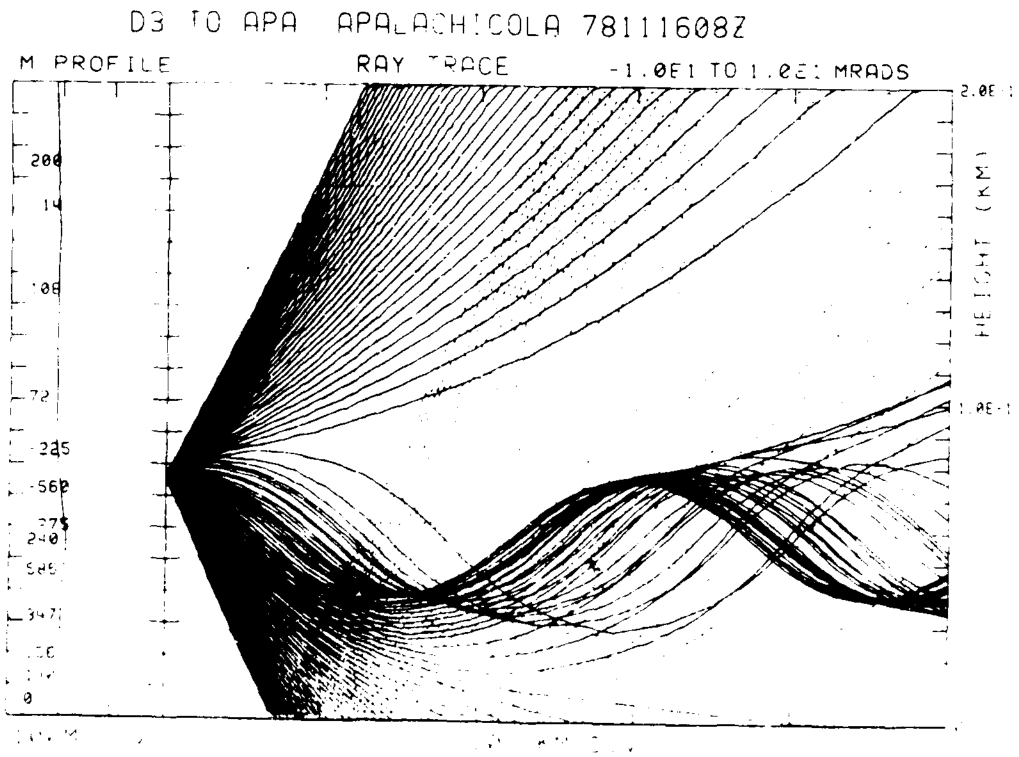


Figure 10-29. Case 10 Raytrace, D3 to APA, Apalachicola 16 Nov 78, 0800Z, Transmitter Height 76.2 m.

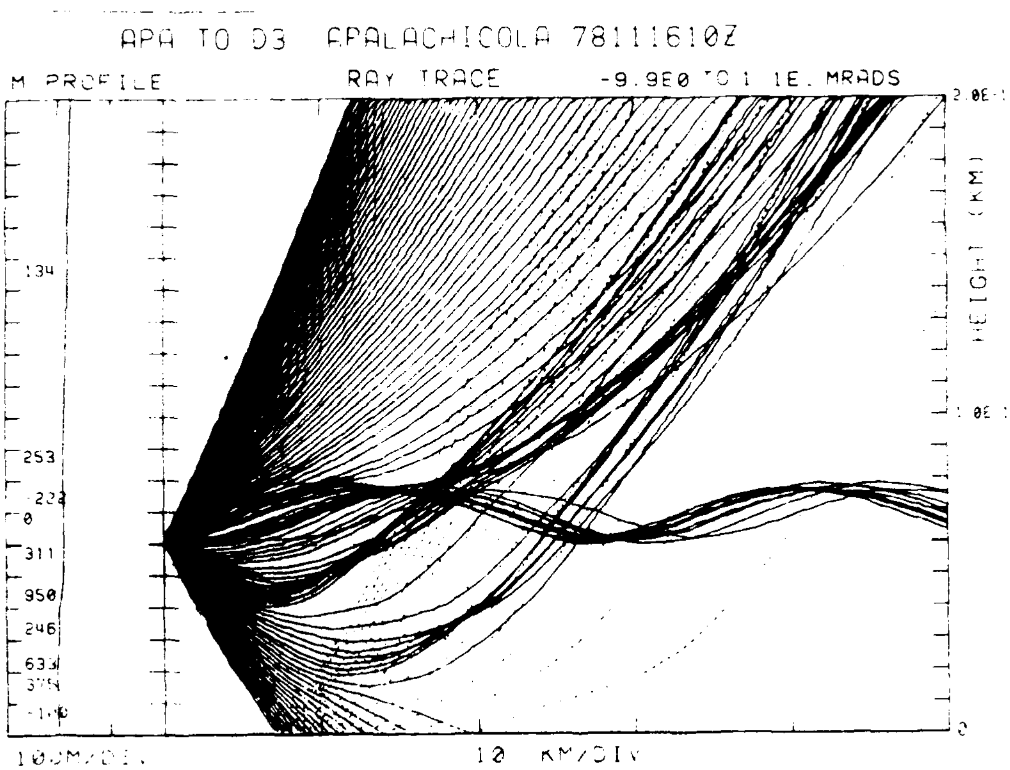


Figure 10-30. Case 10 Raytrace, APA to D3, Apalachicola 16 Nov 78, 1000Z, Transmitter Height 61.0 m.

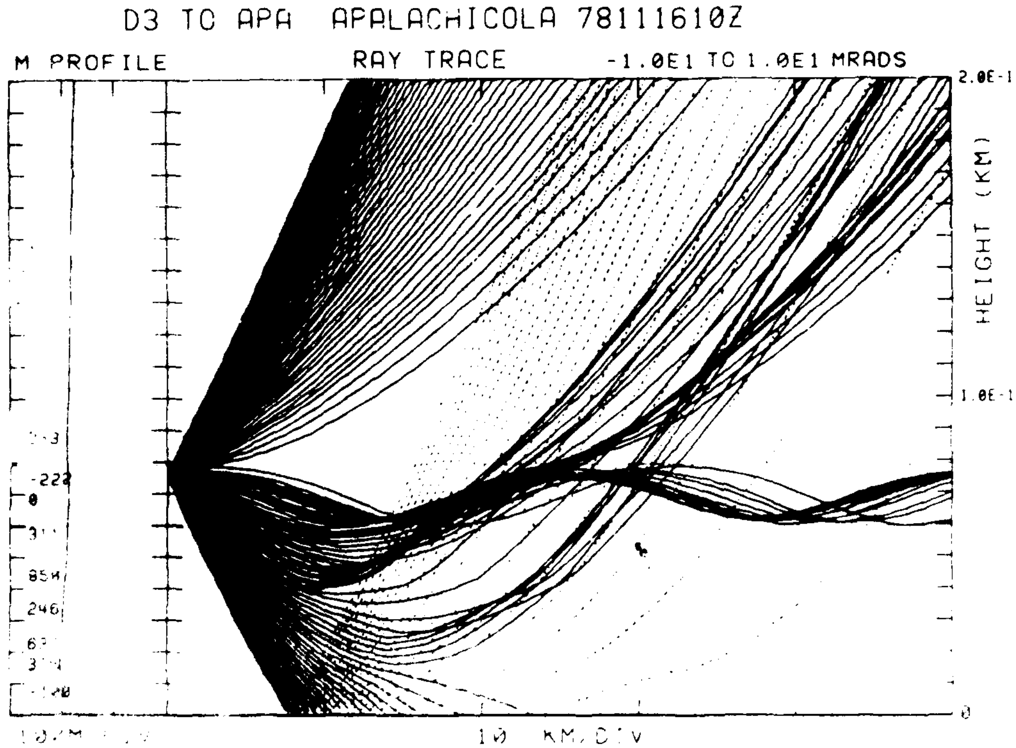


Figure 10-31. Case 10 Raytrace, D3 to APA, Apalachicola 16 Nov 78, 1000Z, Transmitter Height 76.2 m.

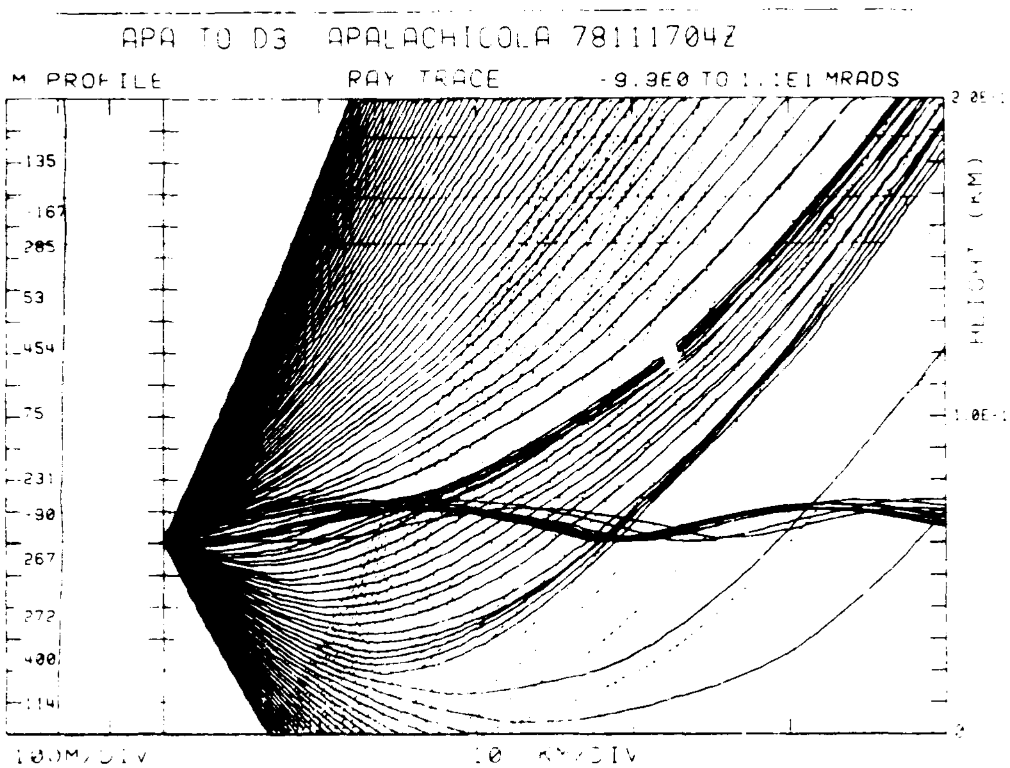


Figure 10-32. Case 10 Raytrace, APA to D3, Apalachicola
17 Nov 78, 0400Z, Transmitter Height 61.0 m.

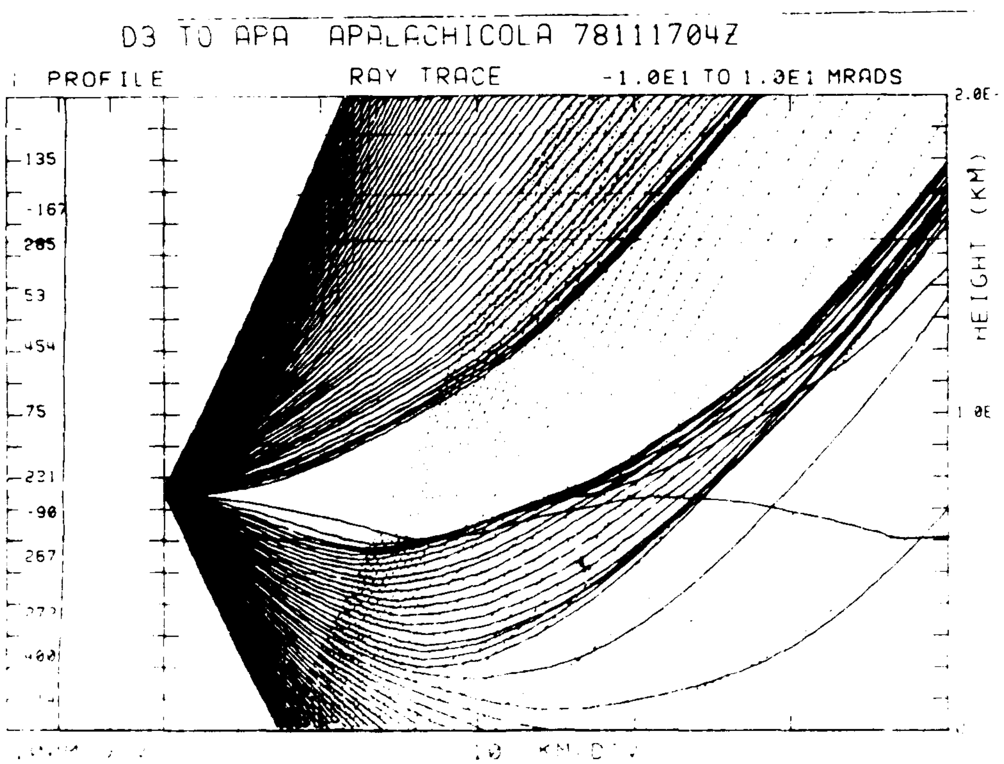


Figure 10-33. Case 10 Raytrace, D3 to APA, Apalachicola
17 Nov 78, 0400Z, Transmitter Height 76.2 m.

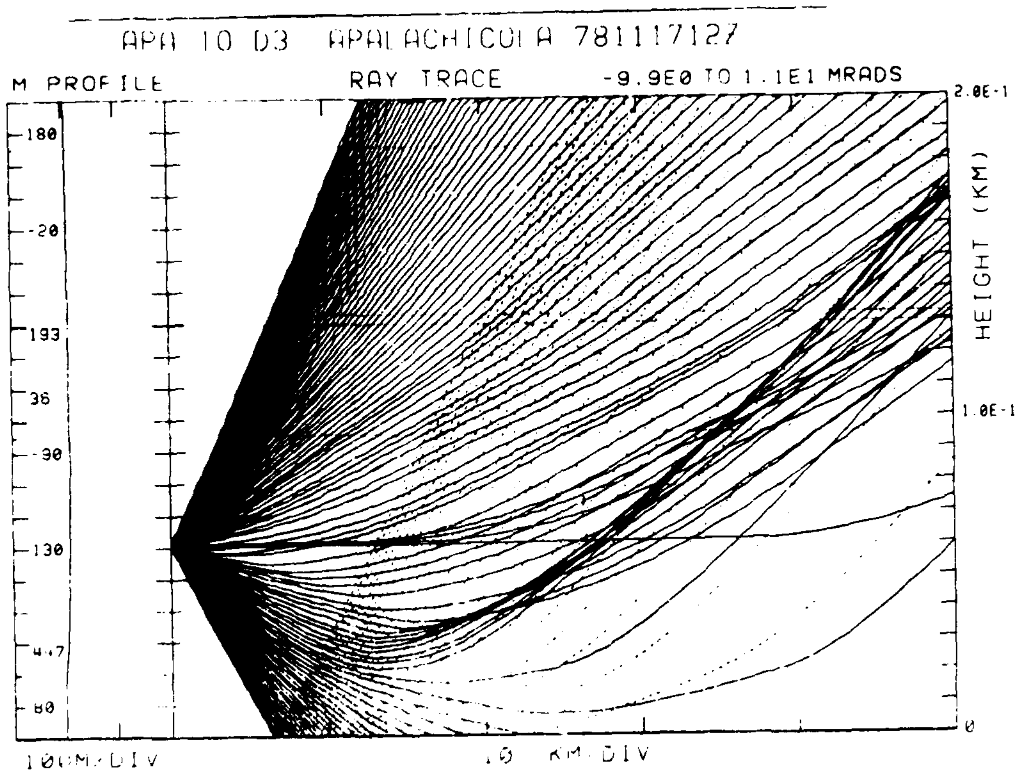


Figure 10-34. Case 10 Raytrace, APA to D3, Apalachicola 17 Nov 78, 1200Z, Transmitter Height 61.0 m.

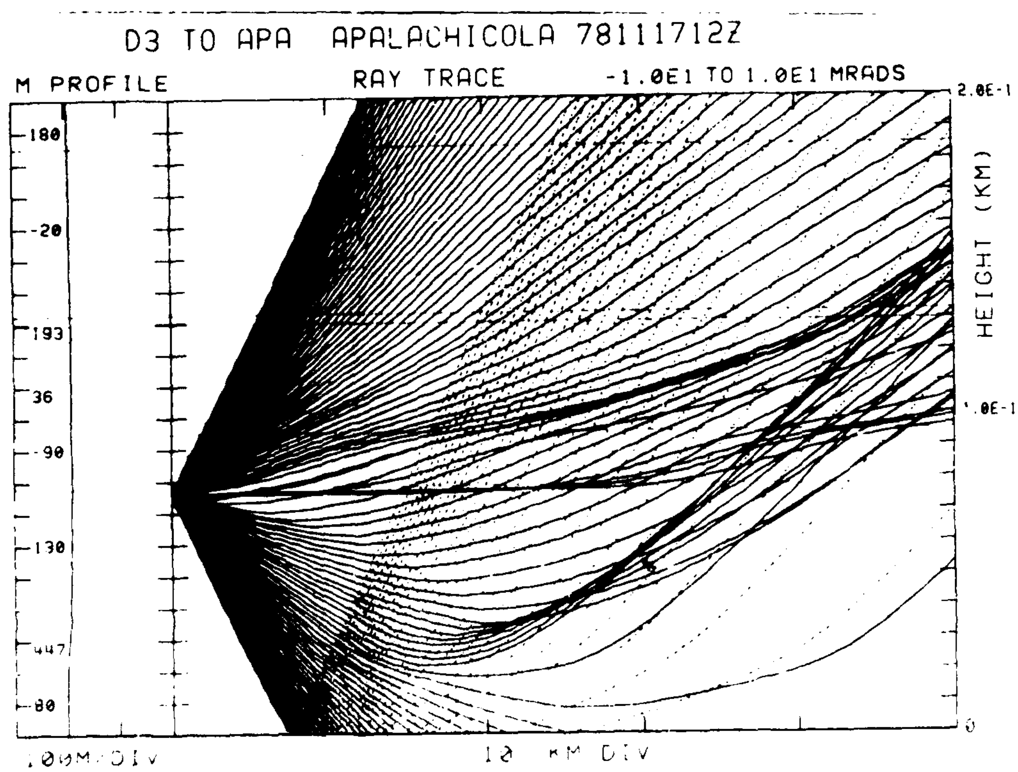


Figure 10-35. Case 10 Raytrace, D3 to APA, Apalachicola 17 Nov 78, 1200Z, Transmitter Height 76.2 m.

CASE 11

1. Case 11, the final case, was the last "good" case studied. It was also a long period (19 Nov/11Z-23 Nov/01Z) and contained the most data. Figures 11-1 through 11-4 represent typical RSL levels recorded at APA as received for D3. The RSL stability compares with that indicated in Case 10.

2. Figures 11-5 through 11-14 depict the synoptic weather pattern for the period. As the maps indicate, a weak, slow-moving cloud front (sometimes stationary) moved southward through the Florida panhandle, then dissipated. Some light rainshower activity occurred in the vicinity of Apalachicola on 21 November at 03Z. The pressure gradient was relatively weak throughout the period, and surface winds were normally light northeasterly or calm.

3. Tables 11-1 through 11-3 give surface observations for the three reporting stations. Scattered to broken clouds, light winds, and good visibilities were prevalent.

4. Figures 11-15 through 11-25 depict available M-profiles for the period. Practically all possibilities of variation in M occurred here.. There are surface-based ducts, elevated ducts, normal profiles, intense elevated subrefraction, and the usual minor fluctuations in M. No explicit trend is readily apparent.

5. Raytraces for the period are shown in Figures 11-26 through 11-81. Generally, the ray patterns in the vicinity of the receiver are disrupted, but not to an extensive degree. Considering that this is a "good" RSL period, little more can be deduced from the raytraces.

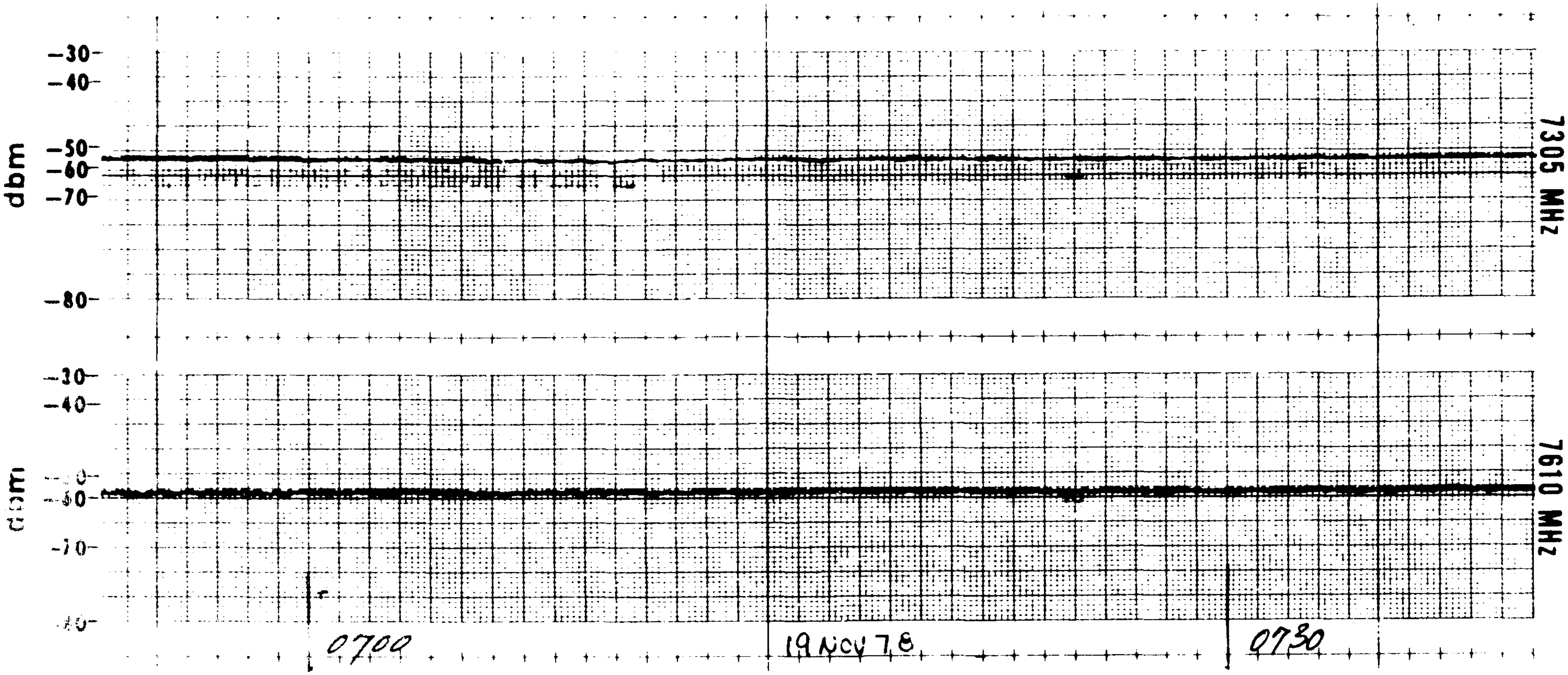


Figure 11-1 Case 11 RSL Strip Chart showing typical stable pattern on both channels of APA received from D3. Times are from 0653 EST to 0740 EST, 19 Nov 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

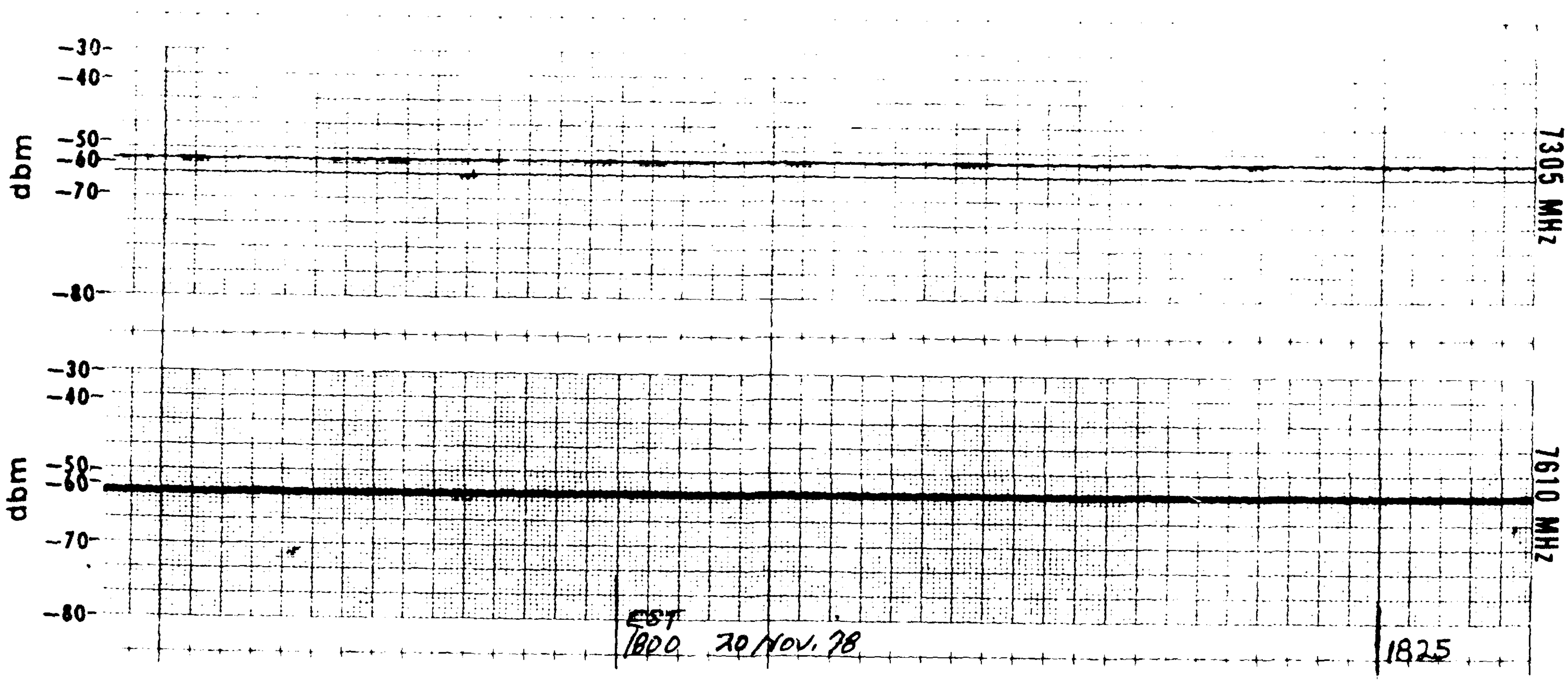


Figure 11-2 Case 11 RSL Strip Chart showing typical stable pattern on both channels of APA received from D3. Times are from 1743 EST to 1830 EST, 20 Nov 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

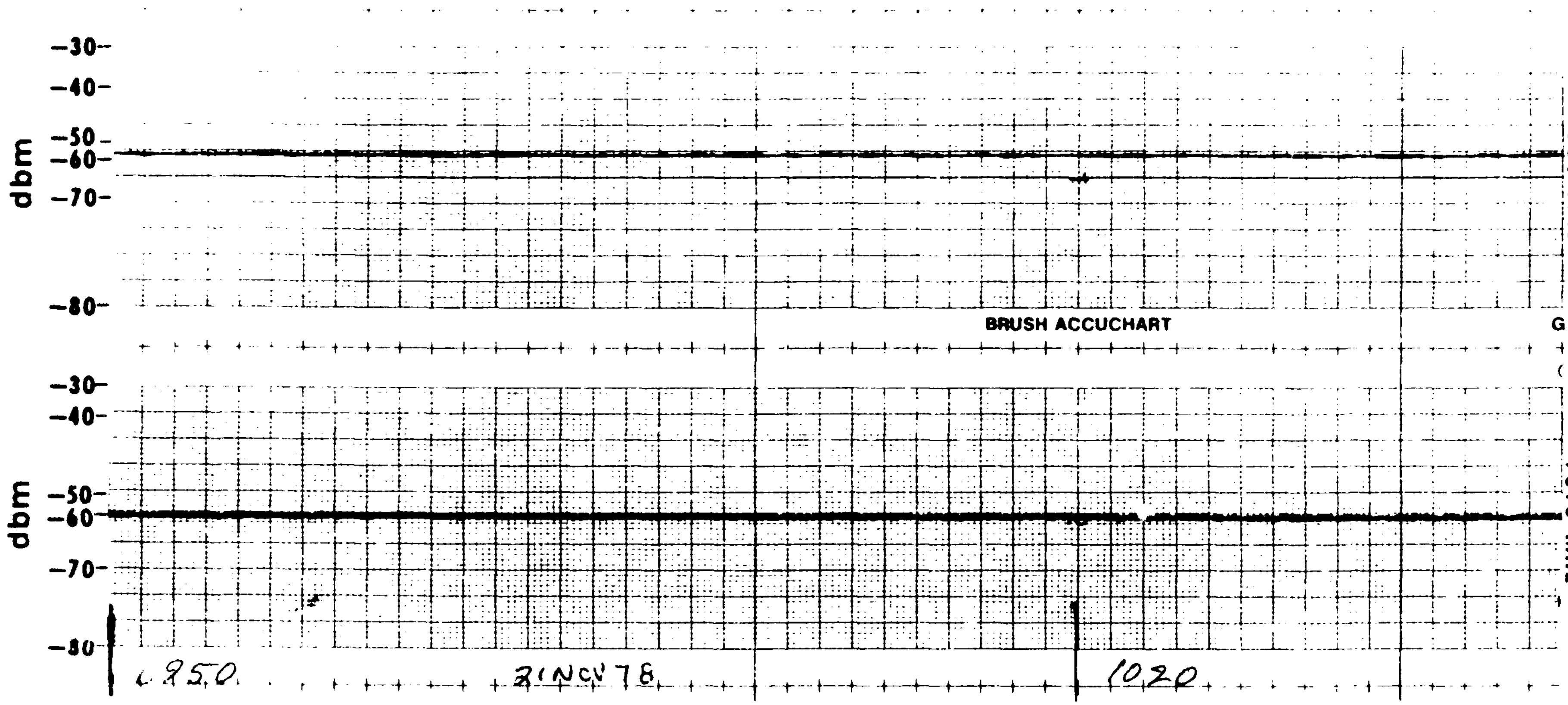


Figure 11-3 Case 11 RSL Strip Chart showing typical stable pattern on both channels of APA received from D3. Times are from 0950 EST to 1035 EST, 21 Nov 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

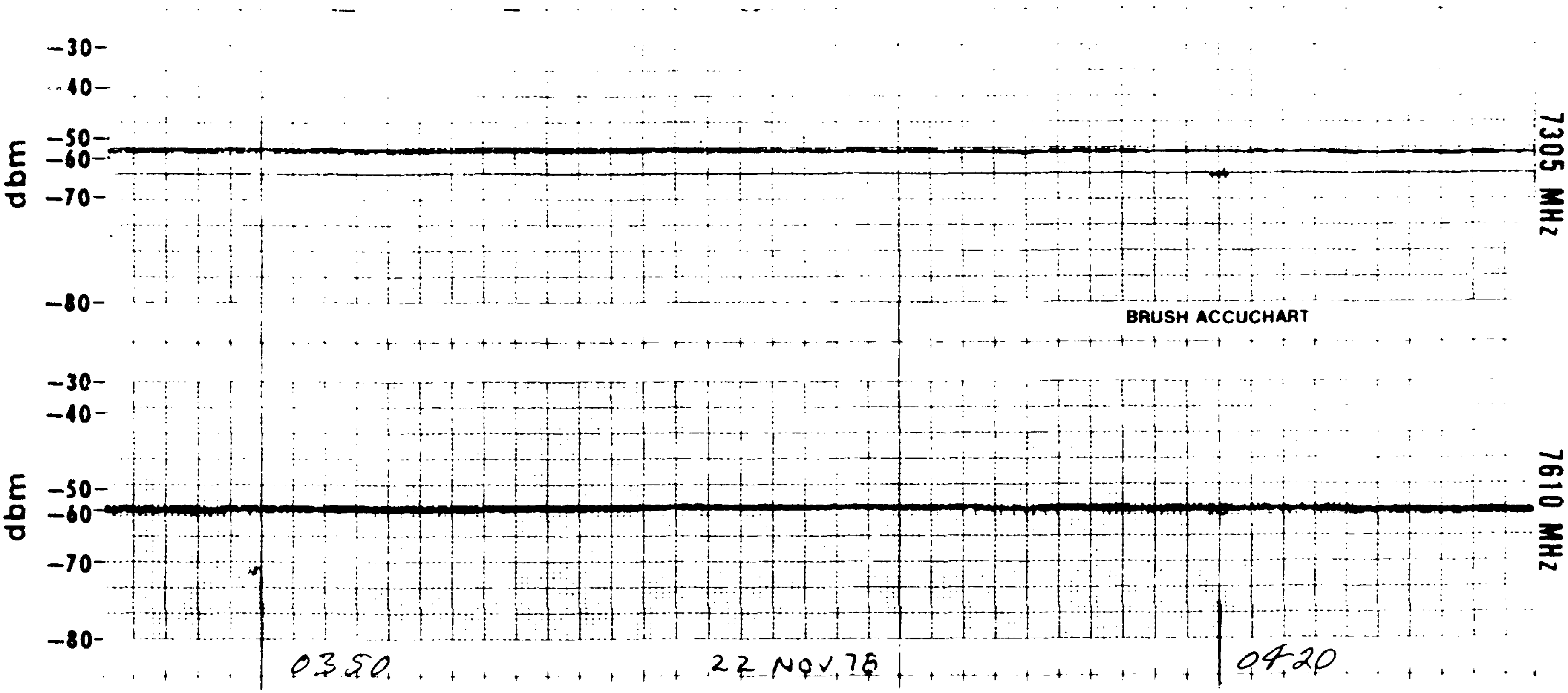


Figure 11-4 Case 11 RSL Strip Chart showing typical stable pattern on both channels of APA received from D3. Times are from 0345 EST to 0430 EST, 22 Nov 78. The dbm calibration levels are listed on the left, and channel frequencies in MHz are listed on the right.

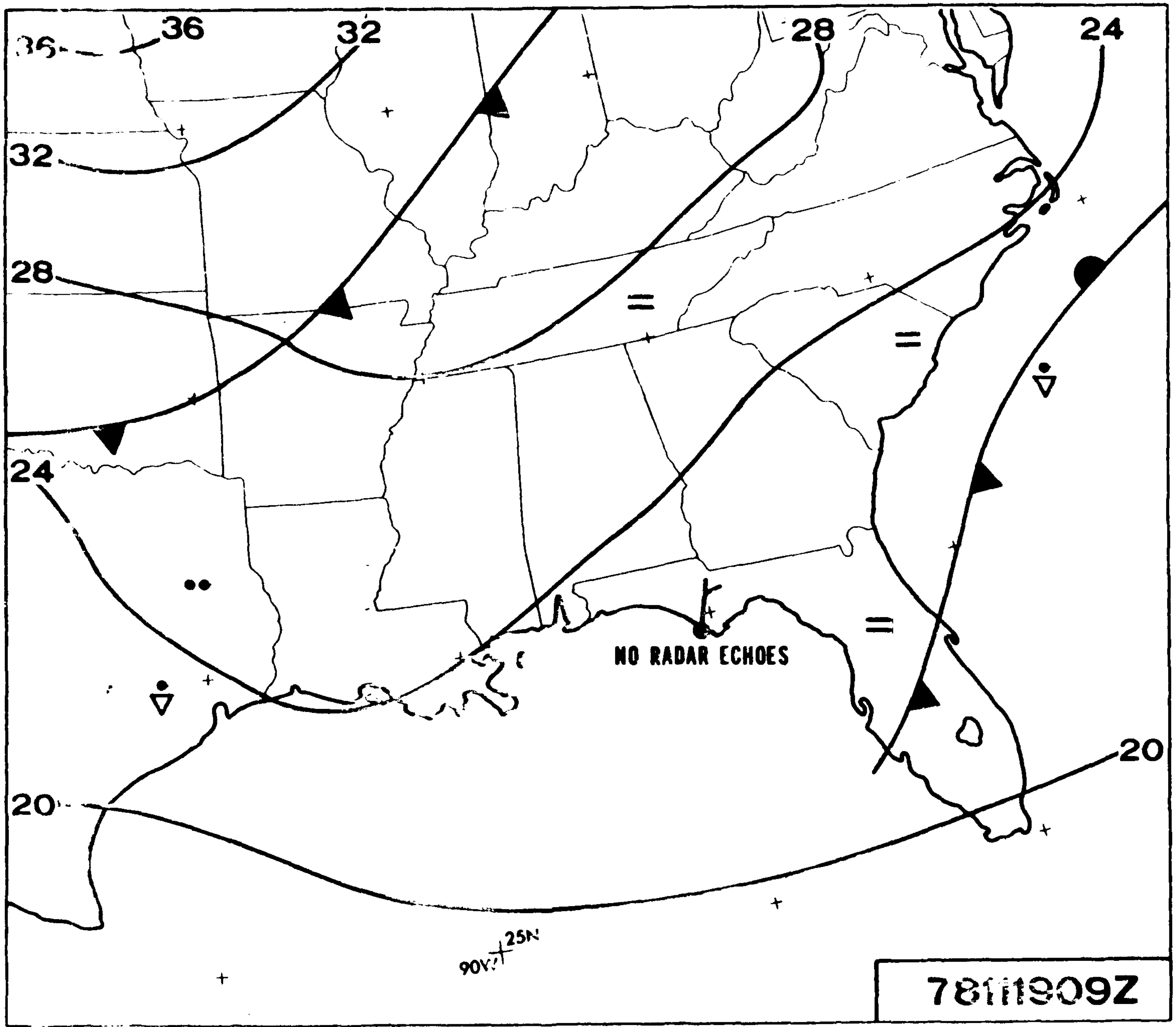


Figure 11-5 7811l909Z Synoptic Chart

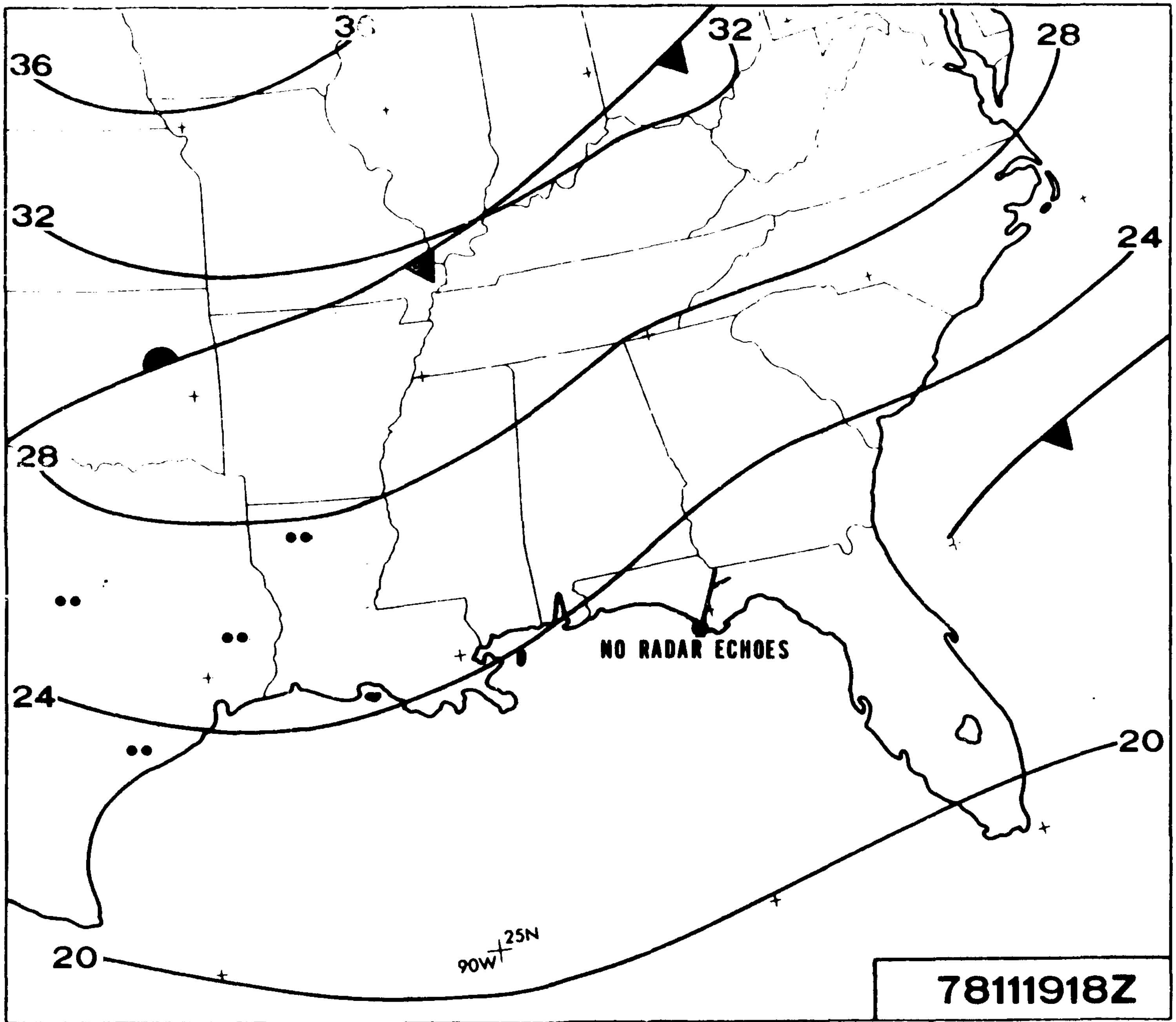


Figure 11-6 78111918Z Synoptic Chart

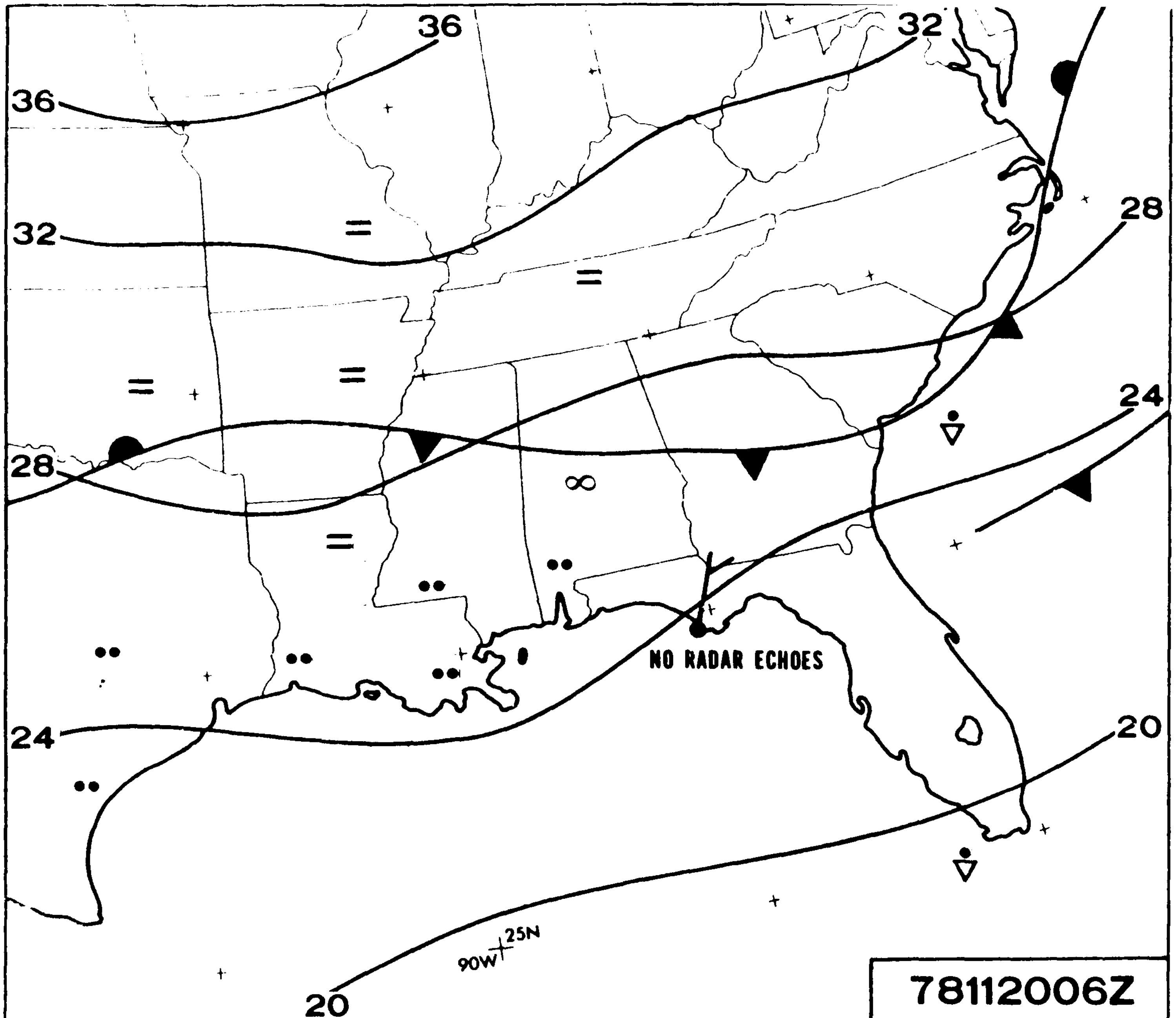


Figure 11-7 78112006Z Synoptic Chart

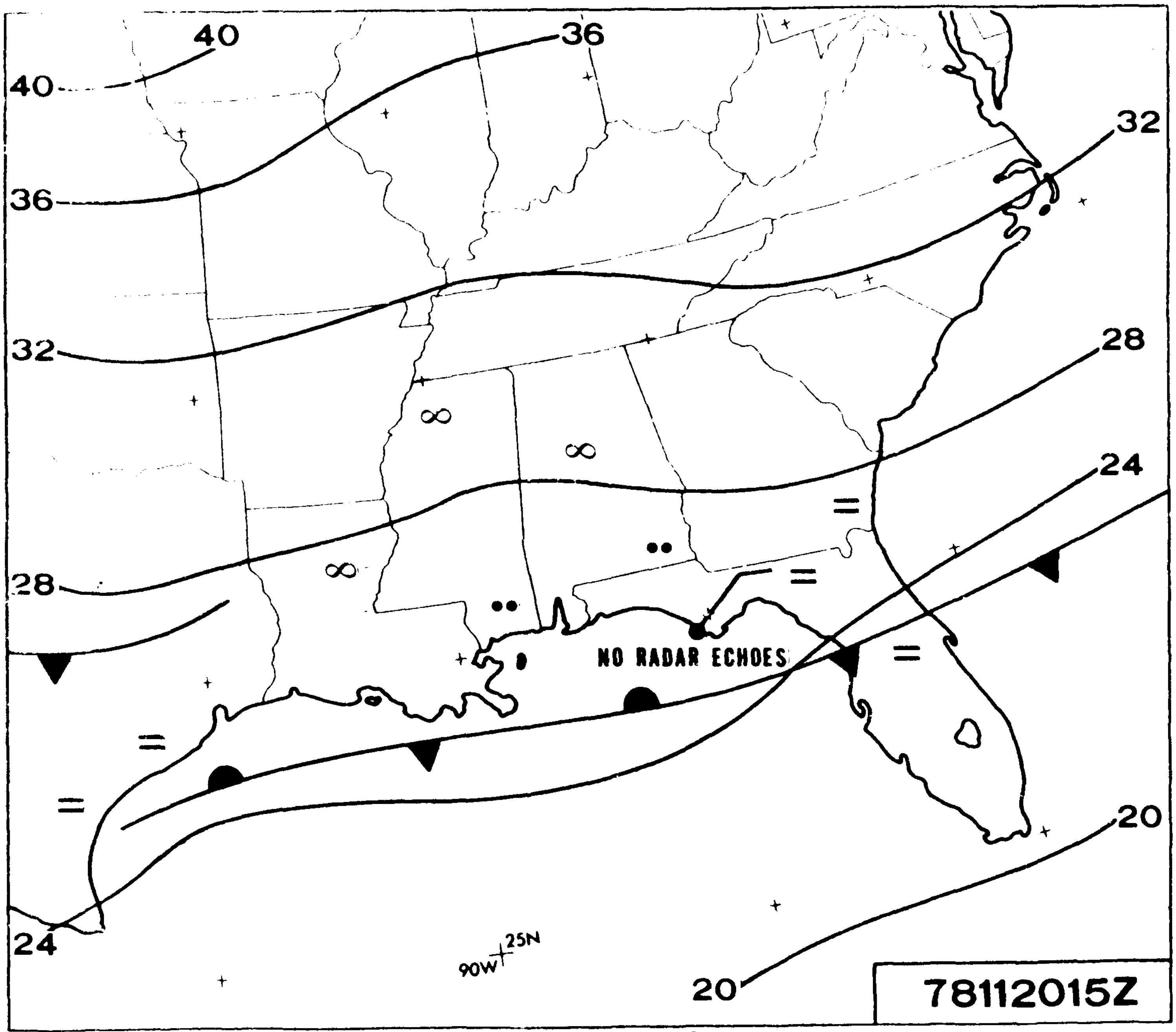


Figure 11-8 78112015Z Synoptic Chart

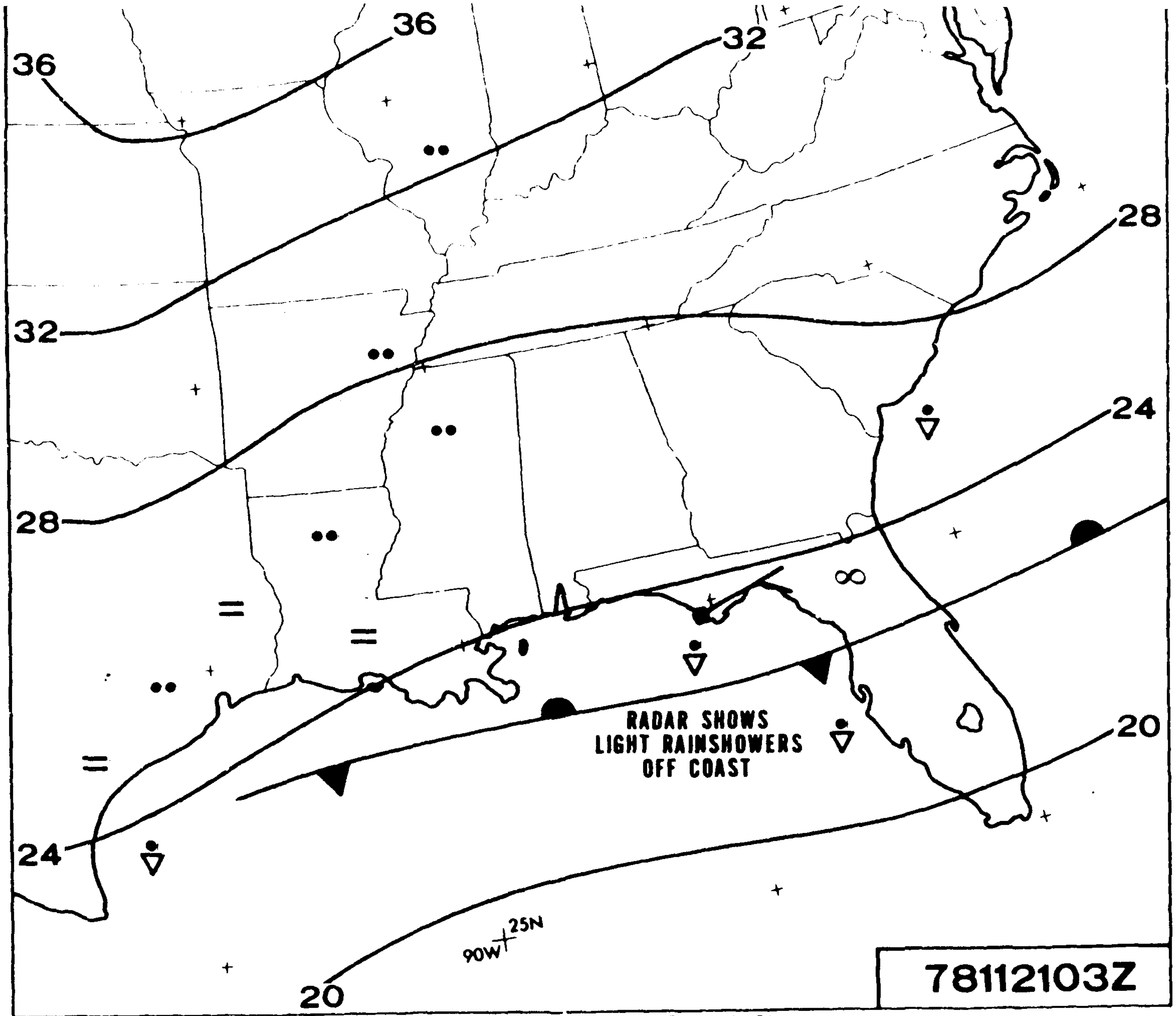


Figure 11-9 78112103Z Synoptic Chart

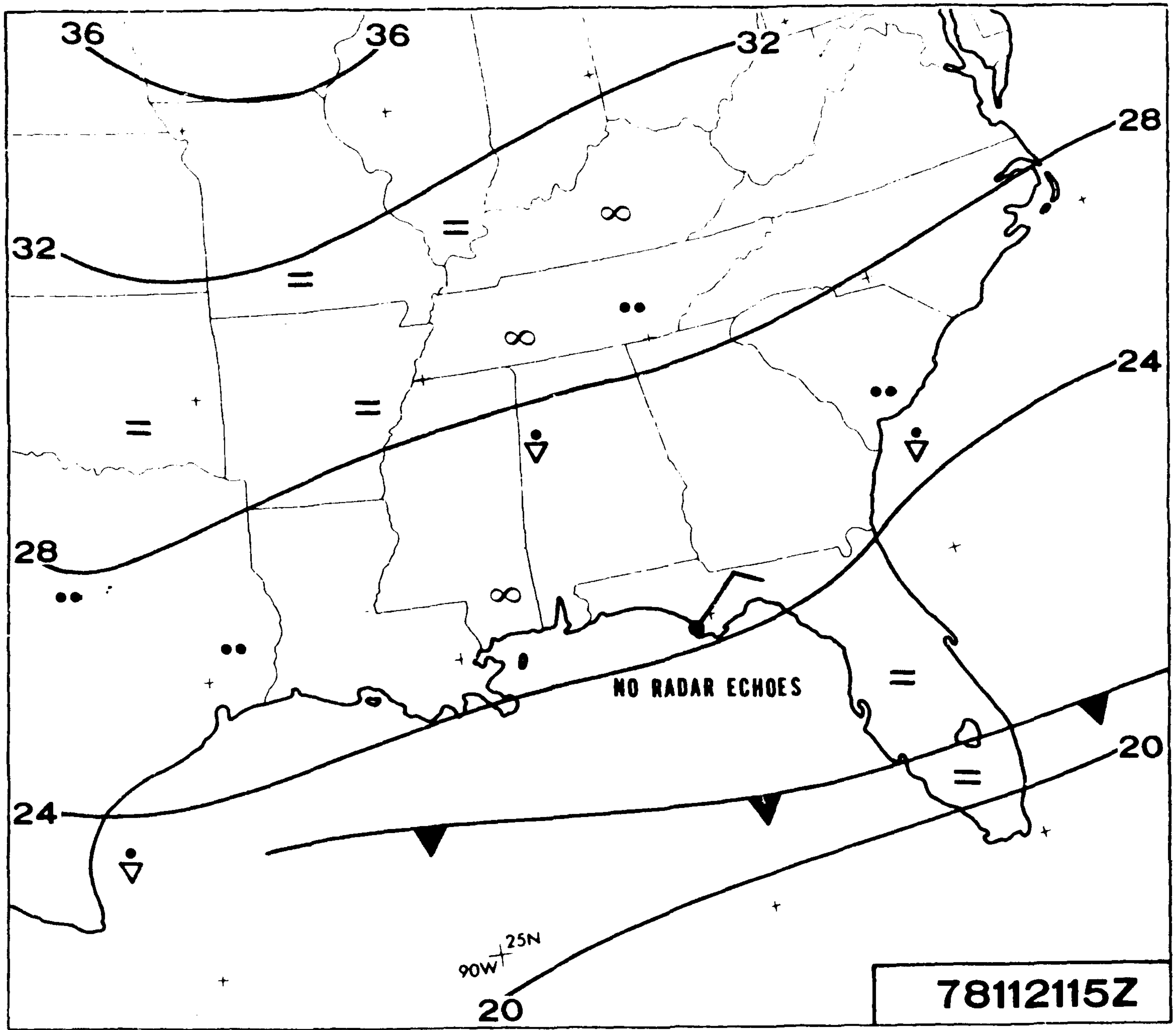


Figure 11-10 78112115Z Synoptic Chart

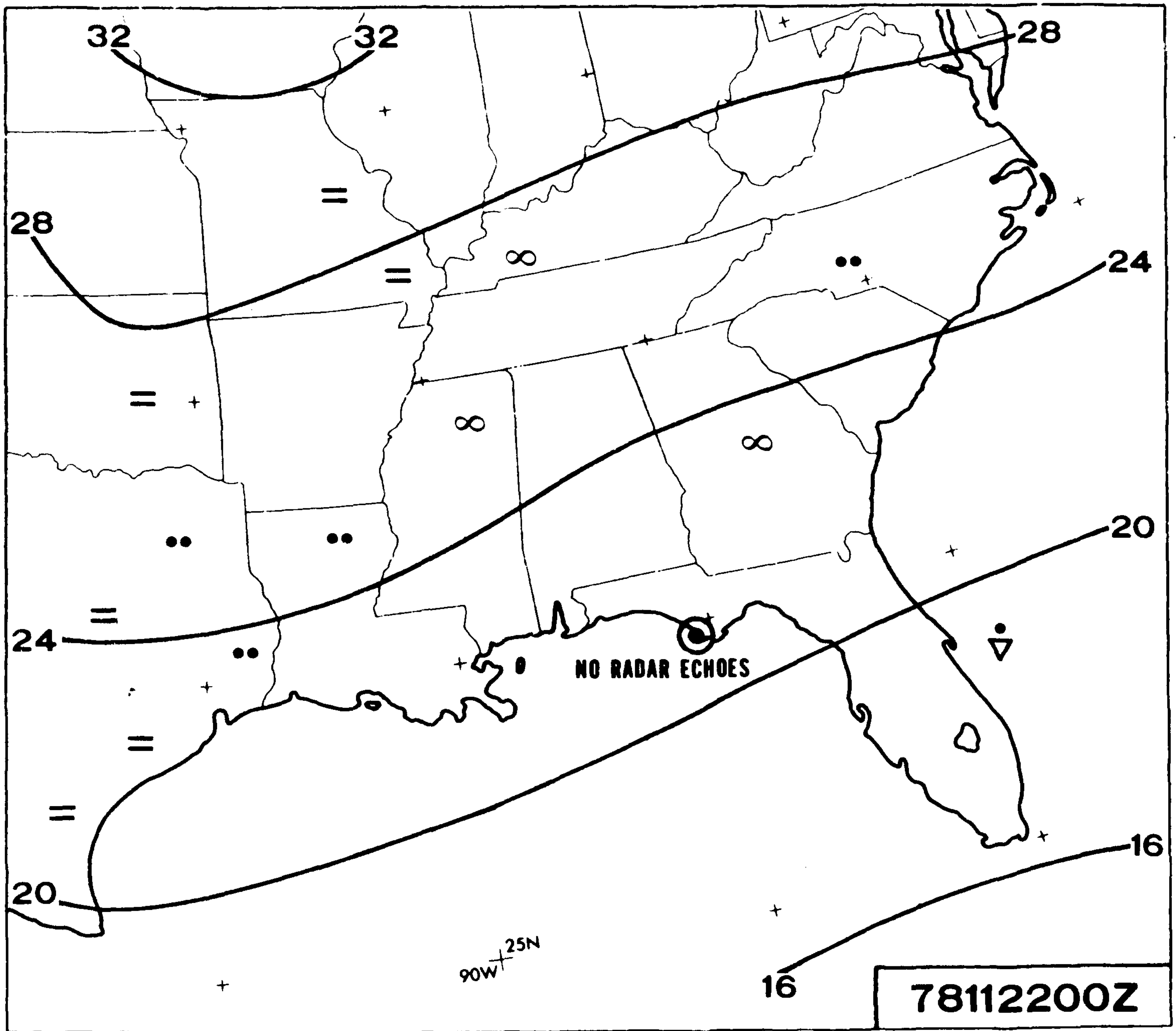


Figure 11-11 78112200Z Synoptic Chart

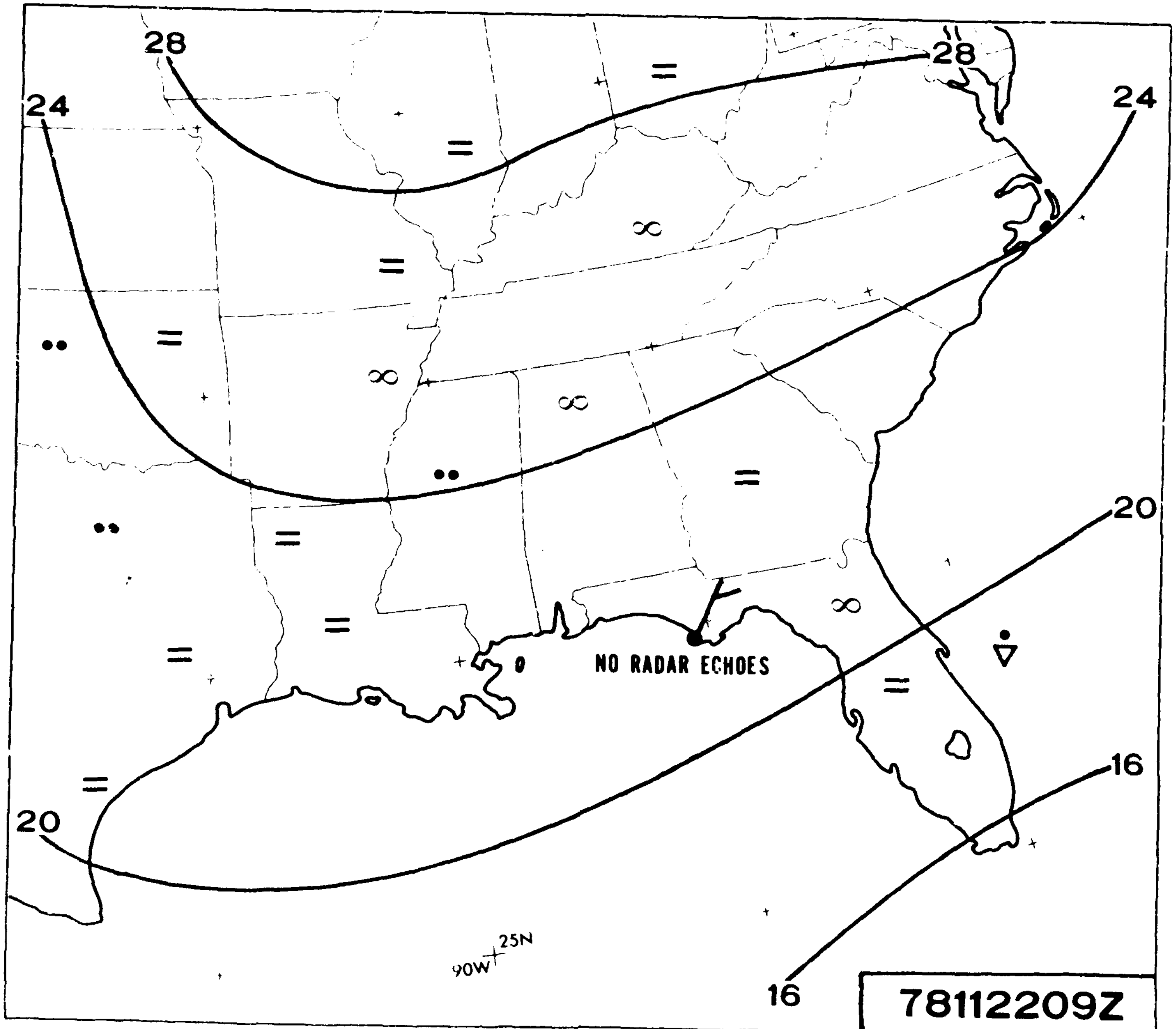


Figure 11-12 78112209Z Synoptic Chart

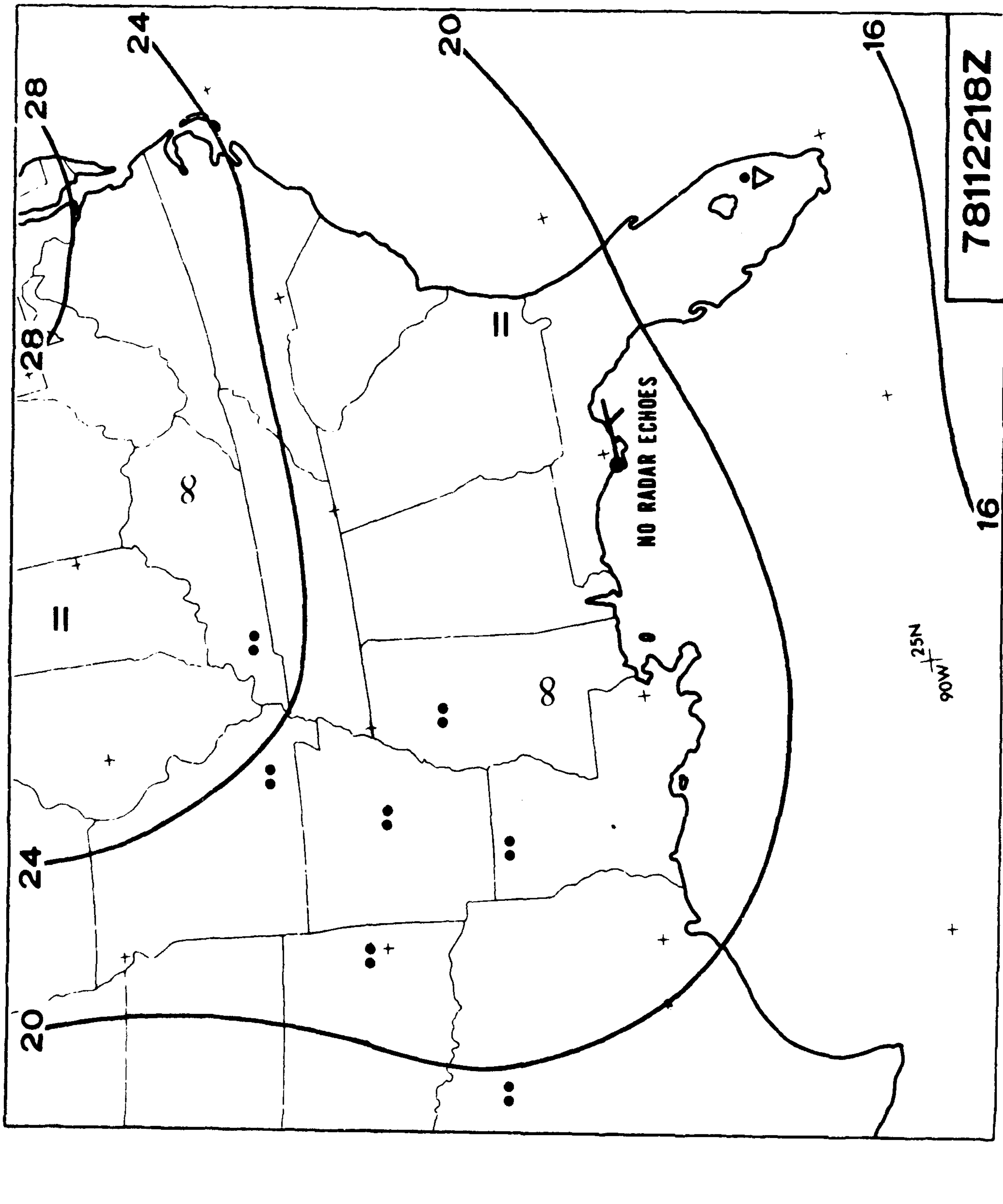


Figure 11-13 78112218Z Synoptic Chart

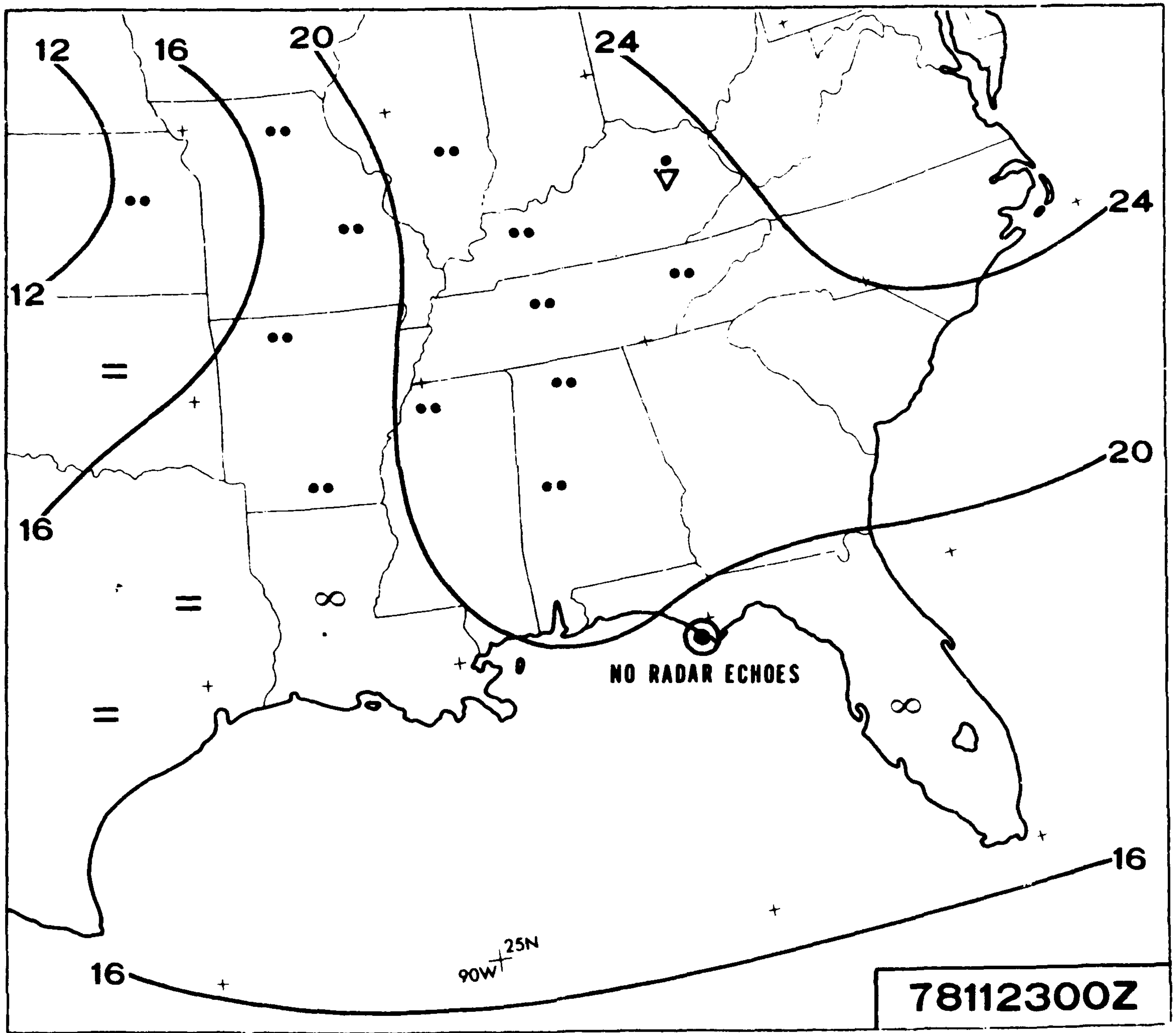


Figure 11-14 78112300Z Synoptic Chart

Table 11-1. Case 11, Apalachicola Surface Weather, 19 Nov 78, 1100Z - 23 Nov 78, 0100Z.

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 19 09	15.0	4.4	30	7	CLR	7	None
12	13.9	4.5	40	9	CLR	7	None
15	18.3	9.4	60	9	CLR	7	None
18	23.9	17.2	80	7	SCT	7	None
21	23.3	13.3	160	4	SCT	7	None
11 20 00	15.6	2.8	CALM	CALM	SCT	7	None
03	14.4	1.6	160	5	SCT	7	None
06	15.6	7.8	--	--	SCT	7	None
15	19.4	1.6	80	8	OVC	7	None
18	21.1	3.3	70	10	OVC	7	None
21	21.1	4.4	70	8	BKN	7	None
11 21 00	18.3	2.2	50	3	OVC	7	None
03	16.7	2.3	60	8	SCT	7	None
06	16.1	3.9	60	7	CLR	7	None
09	13.9	3.3	60	7	CLR	7	None
12	12.8	4.5	60	8	CLR	7	None
15	16.6	7.2	70	10	CLR	7	None
18	21.1	8.3	[illegible]	7	CLR	7	None
21	21.1	6.1	160	8	CLR	7	None
11 22 00	15.0	0.0	CALM	CALM	CLR	7	None
03	13.3	0.0	CALM	CALM	CLR	7	None
06	14.4	0.4	70	5	CLR	7	None
09	13.9	1.7	50	7	CLR	7	None
12	13.3	1.6	60	8	BKN	7	None
15	18.8	4.5	80	7	CLR	7	None
18	22.2	6.1	150	9	SCT	7	None
21	22.8	7.2	150	7	BKN	7	None
11 23 00	16.7	0.6	340	3	SCT	7	None
03	15.0	0.0	CALM	CALM	SCT	7	None

Table 11-2. Case 11, Tyndall Surface Weather, 19 Nov 78, 1100Z - 23 Nov 78, 0100Z.

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 19 11	13.9	6.1	30	6	CLR	10	None
12	13.3	5.5	30	6	SCT	10	None
15	18.8	9.5	40	9	SCT	10	None
18	24.4	18.3	40	6	SCT	10	None
21	25.6	20.0	30	4	SCT	10	None

Table 11-2. Case 11, Tyndall Surface Weather, 19 Nov 78, 1100Z - 23 Nov 78, 0100Z (Cont'd).

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 20 00	18.8	10.0	CALM	CALM	CLR	10	None
03	18.3	13.9	20	4	CLR	10	None
06	16.7	12.8	10	6	SCT	10	None
09	16.1	12.2	40	6	BKN	10	None
12	15.0	6.7	60	8	BKN	10	None
1500	18.3	5.5	60	6	OVC	5	H
1529	--	--	70	7	OVC	5	H
1800	20.0	6.1	20	8	OVC	5	H
1851	--	--	50	9	BKN	6	H
21	22.2	7.2	60	6	SCT	5	H
2253	--	--	50	4	BKN	5	H
2325	--	--	50	3	SCT	7	None
11 21 00	18.8	3.9	60	2	SCT	7	None
03	18.8	3.9	60	5	CLR	7	None
06	16.7	5.0	60	4	CLR	7	None
09	15.0	6.7	40	6	SCT	10	None
12	13.9	7.2	50	7	BKN	10	None
1351	--	--	50	7	SCT	10	None
15	16.7	8.4	30	8	SCT	10	None
18	22.8	11.1	20	4	CLR	10	None
21	23.3	13.3	20	7	CLR	7	None
11 22 00	19.4	7.7	CALM	CALM	SCT	7	None
03	16.7	6.1	30	4	CLR	7	None
06	16.1	5.0	50	6	CLR	7	None
09	15.6	5.0	30	4	SCT	7	None
12	16.7	6.1	50	5	BKN	7	None
15	18.9	7.2	90	6	SCT	10	None
18	23.9	10.6	70	5	SCT	10	None
21	25.0	13.3	30	10	SCT	10	None
11 23 00	20.6	6.2	CALM	CALM	CLR	7	None
03	18.8	3.9	CALM	CALM	SCT	7	None

Table 11-3. Case 11, Eglin Surface Weather, 19 Nov 78, 1100Z - 23 Nov 78, 0100Z.

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 19 09	12.8	3.4	360	6	CLR	14	None
11	12.2	3.3	360	6	SCT	14	None
12	11.7	2.8	360	4	SCT	10	None
15	16.7	7.3	30	3	BKN	14	None

Table 11-3 Case 11, Eglin Surface Weather, 19 Nov 78, 1100Z - 23 Nov 78, 0100Z (Cont'd).

Date-Time (1978) (Z)	Temperature (°C)	Dew-Point Depression (°C)	Wind Direction (degrees)	Wind Speed (kt)	Sky Cover	Visibility (mi)	Weather
11 19 18	23.9	18.3	10	6	BKN	14	None
21	26.7	26.7	360	6	BKN	14	None
11 20 00	18.9	12.2	CALM	CALM	SCT	14	None
03	18.8	13.4	360	3	SCT	14	None
06	16.1	10.0	10	4	BKN	14	None
09	15.0	7.8	CALM	CALM	BKN	14	None
12	15.6	5.0	60	4	BKN	14	None
1403	--	--	350	10	OVC	9	None
1500	17.2	4.4	20	10	OVC	7	None
1540	--	--	30	10	BKN	7	None
18	21.7	5.6	40	6	OVC	6	H
1911	--	--	70	5	BKN	6	H
21	22.8	5.6	100	5	SCT	7	None
11 21 00	21.1	2.8	CALM	CALM	SCT	7	None
03	18.8	2.2	30	4	CLR	7	None
06	16.7	5.0	60	3	CLR	7	None
09	15.0	5.6	20	4	BKN	8	None
12	14.4	5.5	CALM	CALM	SCT	10	None
15	16.7	7.3	10	4	SCT	10	None
18	22.8	10.0	50	4	SCT	10	None
21	23.9	12.8	360	8	SCT	10	None
11 22 00	18.9	7.8	CALM	CALM	CLR	14	None
03	15.0	5.0	CALM	CALM	CLR	10	None
06	14.4	4.4	10	2	CLR	10	None
09	13.3	2.7	10	4	CLR	9	None
12	12.8	1.7	10	4	BKN	6	F
15	18.9	6.1	60	6	BKN	6	H
18	22.8	8.9	110	6	BKN	7	None
21	22.2	6.1	160	4	BKN	7	None
11 23 00	19.4	3.3	CALM	CALM	BKN	8	None
01	17.2	2.2	CALM	CALM	SCT	9	None
03	16.7	1.7	CALM	CALM	BKN	9	None

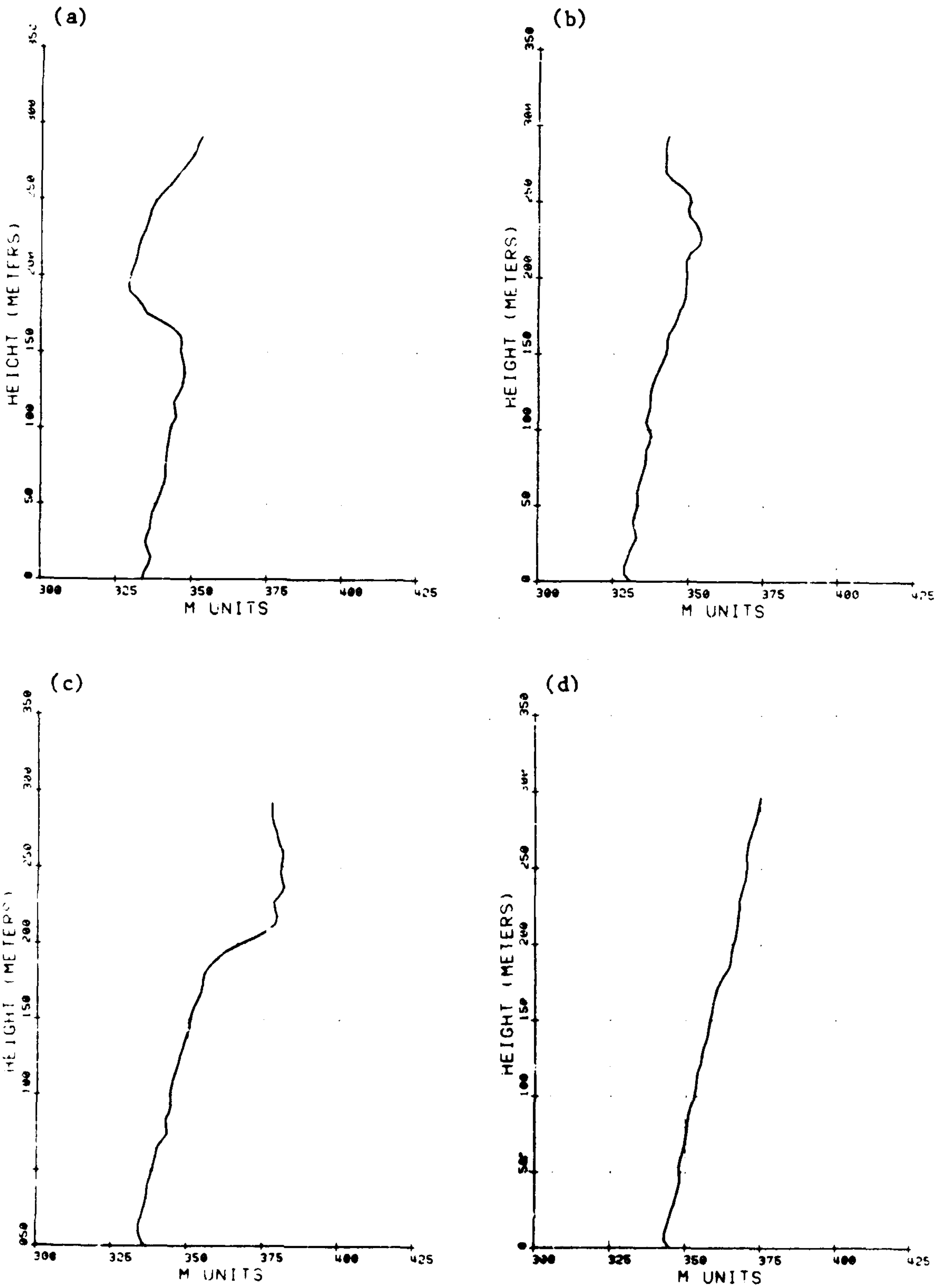


Figure 11-15 Case 11 M-Profiles: a. Cape San Blas, 19 Nov 78, 1400Z; b. Cape San Blas, 19 Nov 78, 1600Z; c. Cape San Blas, 21 Nov 78, 1400Z; d. Cape San Blas, 21 Nov 78, 1600Z.

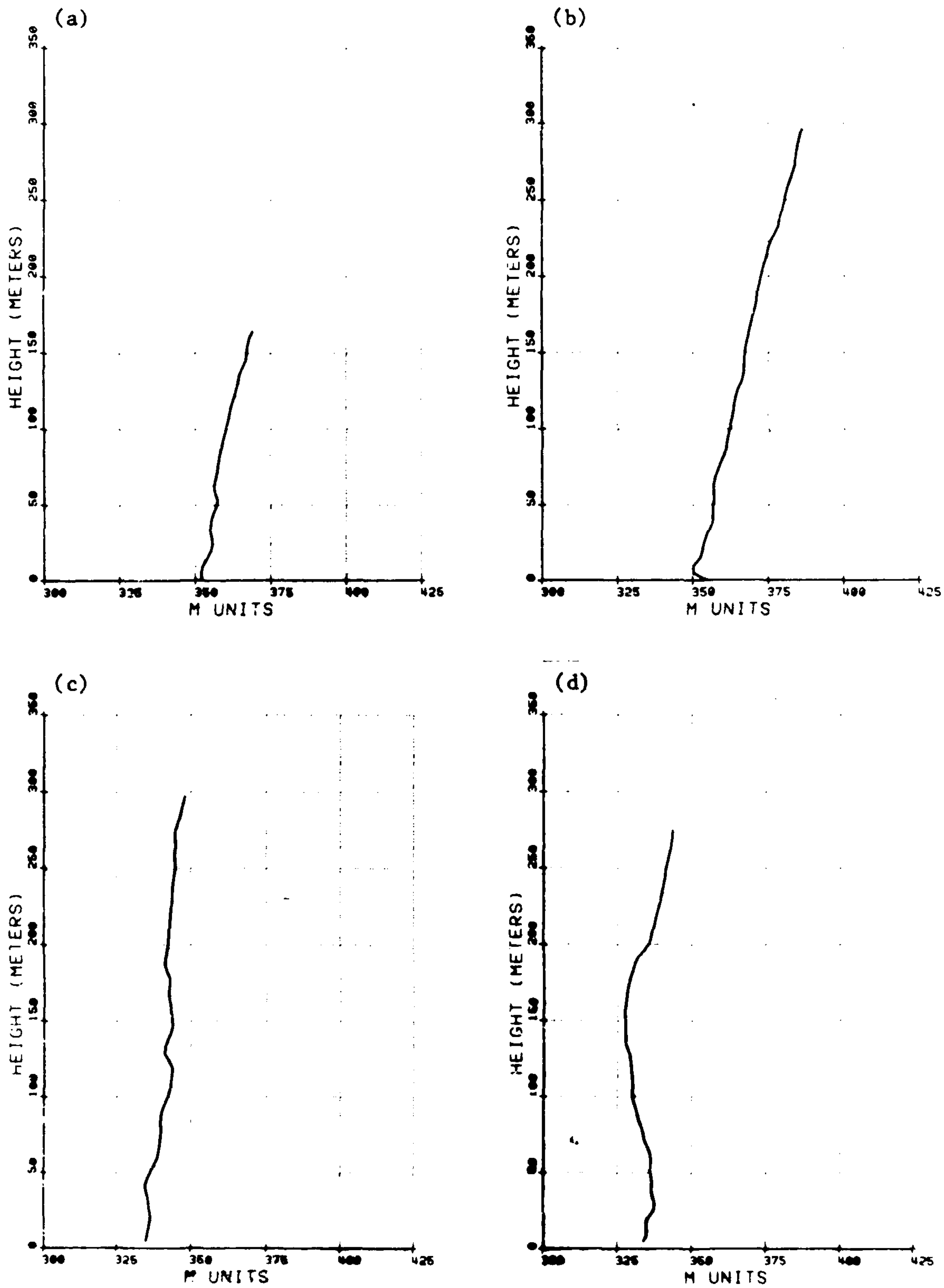


Figure 11-16 Case 11 M-Profiles: a. Cape San Blas, 22 Nov 78, 1500Z; b. Cape San Blas, 22 Nov 78, 1600Z; c. Apalachicola, 20 Nov 78, 0100Z; d. Apalachicola, 20 Nov 78, 0200Z.

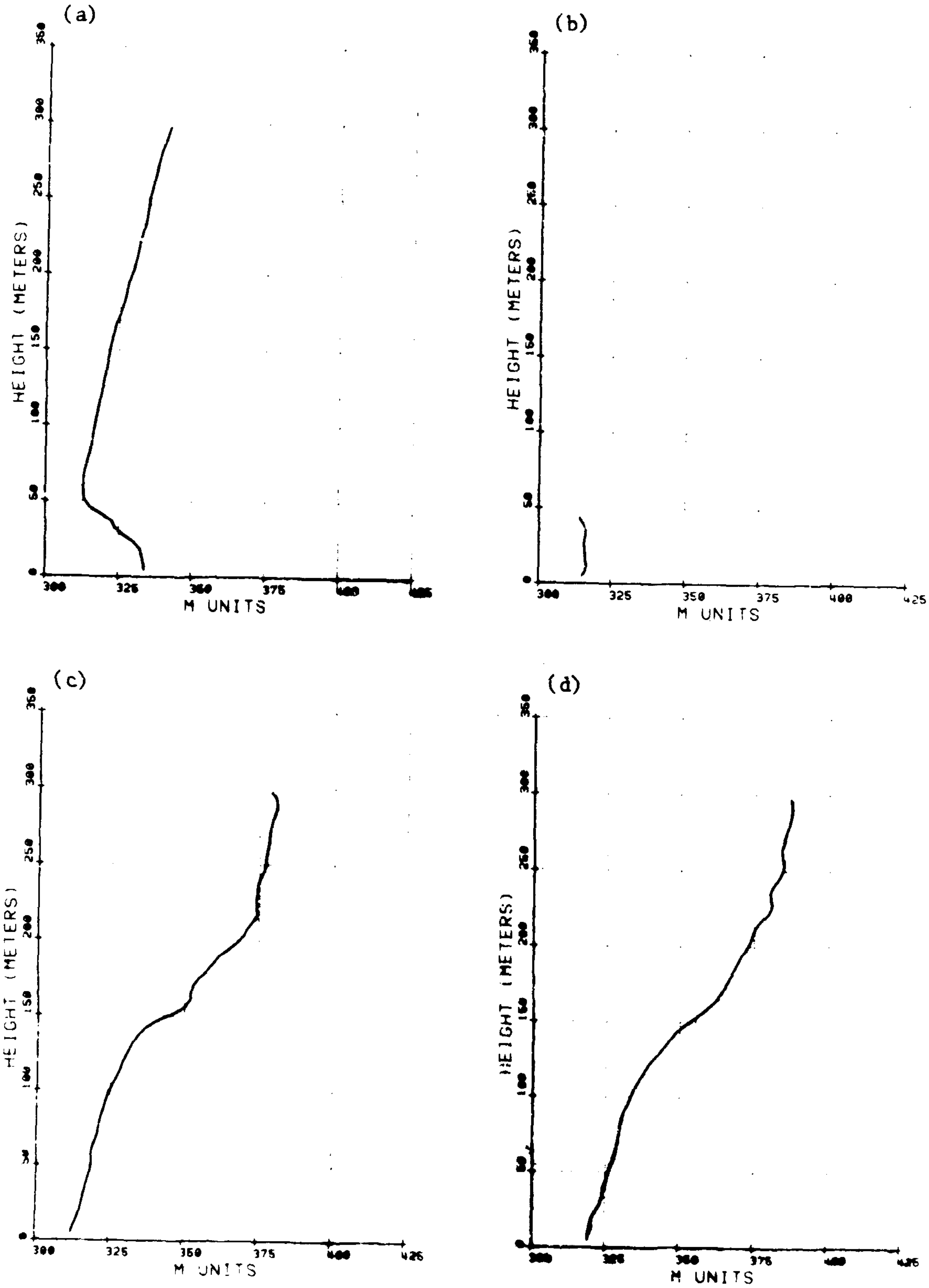


Figure 11-17 Case 11 M-Profiles : a. Apalachicola, 20 Nov 78, 0300Z; b. Apalachicola, 20 Nov 78, 0400Z; c. Apalachicola, 20 Nov 78, 0800Z; d. Apalachicola, 20 Nov 78, 0900Z.

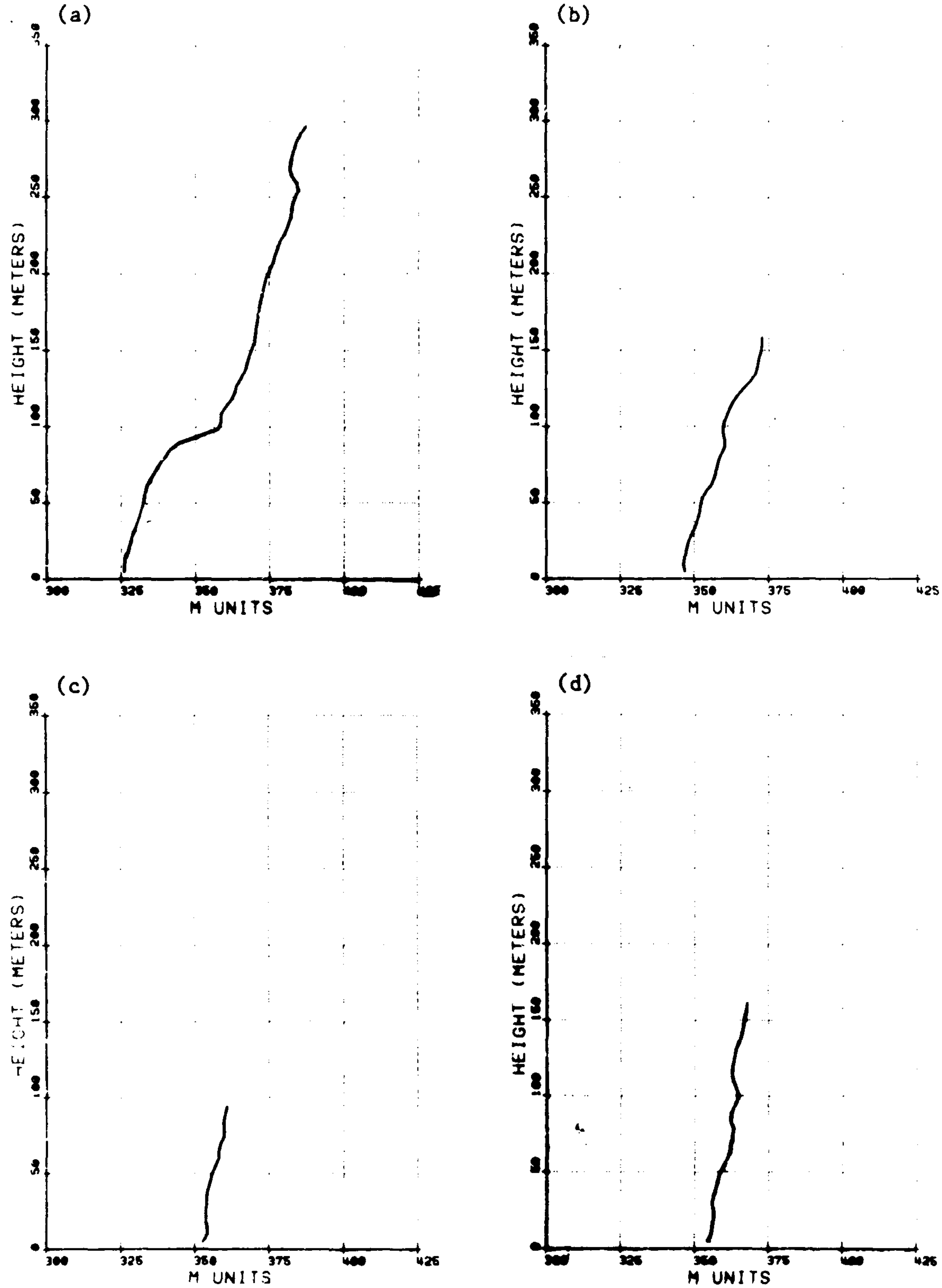


Figure 11-18 Case 11 M-Profiles: a. Apalachicola, 20 Nov 78, 1000Z; b. Apalachicola, 20 Nov 78, 1300Z; c. Apalachicola, 20 Nov 78, 1400Z; d. Apalachicola, 20 Nov 78, 1500Z.

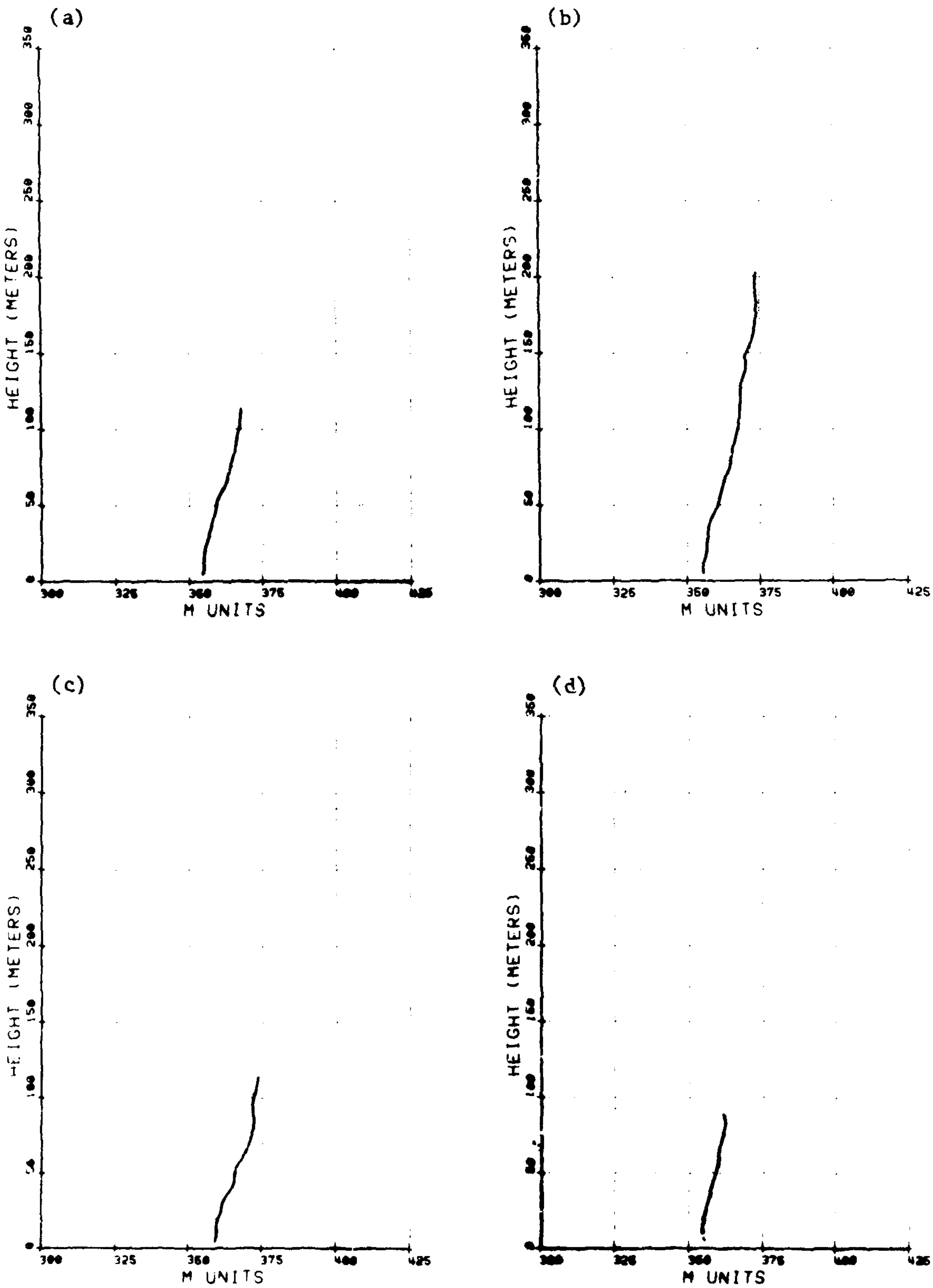


Figure 11-19 Case 11 M-Profiles : a. Apalachicola, 20 Nov 78, 1600Z; b. Apalachicola, 20 Nov 78, 1700Z; c. Apalachicola, 20 Nov 78, 1800Z; d. Apalachicola, 20 Nov 78, 1900Z.

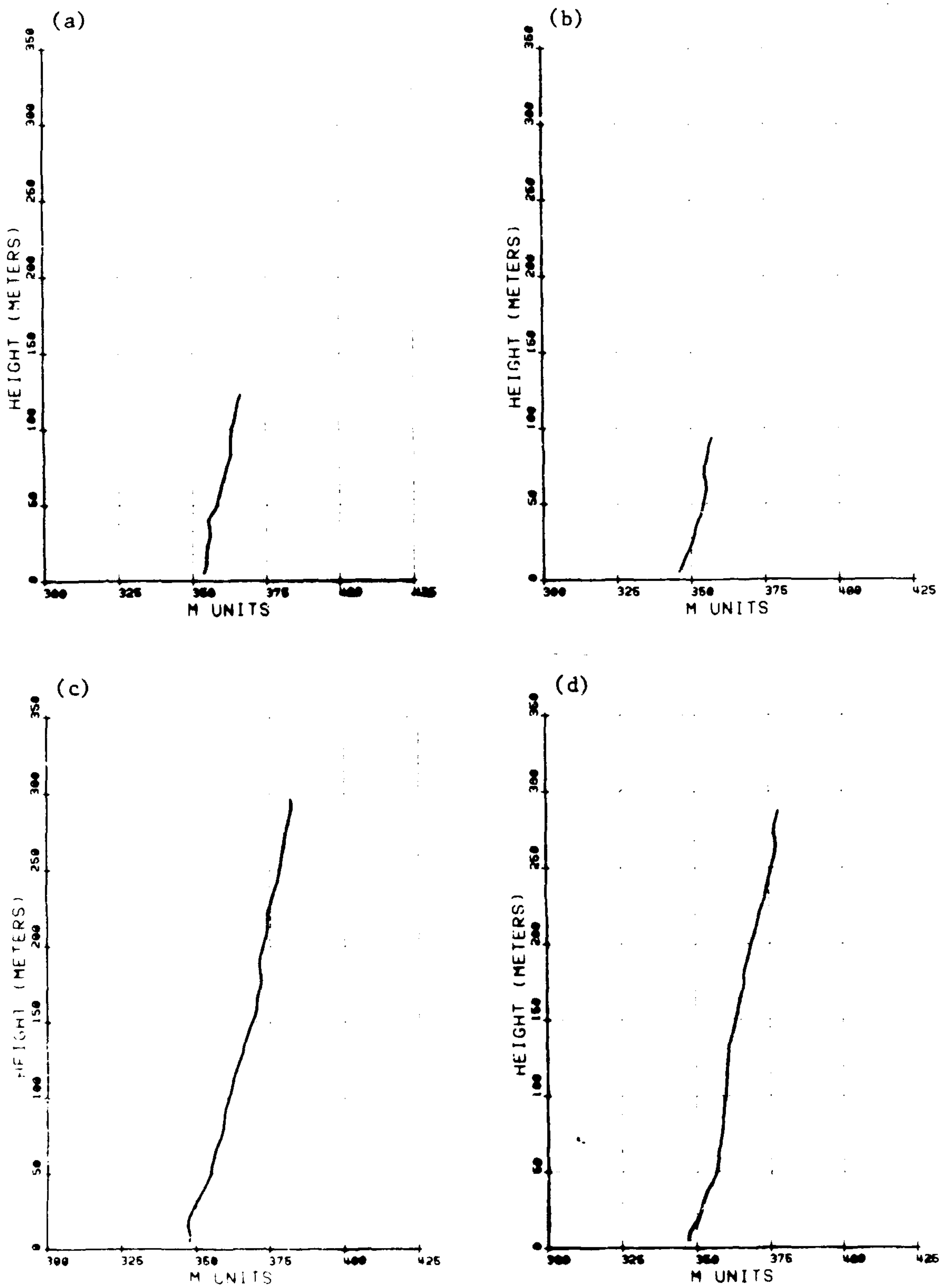


Figure 11-20 Case 11 M-Profiles: a. Apalachicola, 20 Nov 78, 2000Z; b. Apalachicola, 20 Nov 78, 2100Z; c. Apalachicola, 20 Nov 78, 2200Z; d. Apalachicola, 21 Nov 78, 0100Z.

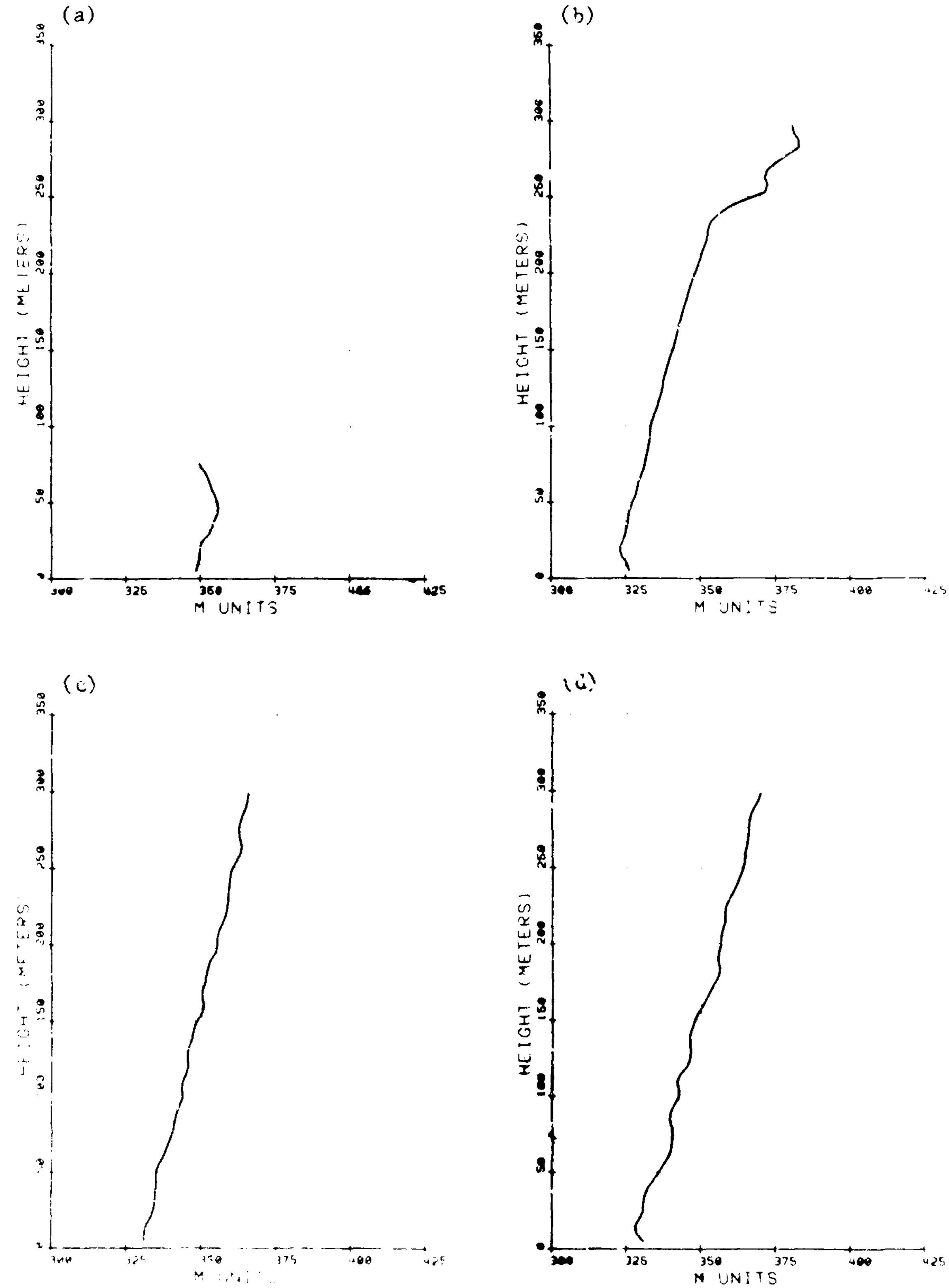


Figure 11-21 Case 11 M-Profiles : a. Apalachicola, 21 Nov 78, 0200Z; b. Apalachicola, 21 Nov 78, 1300Z; c. Apalachicola, 21 Nov 78, 1600Z; d. Apalachicola, 21 Nov 78, 1700Z.

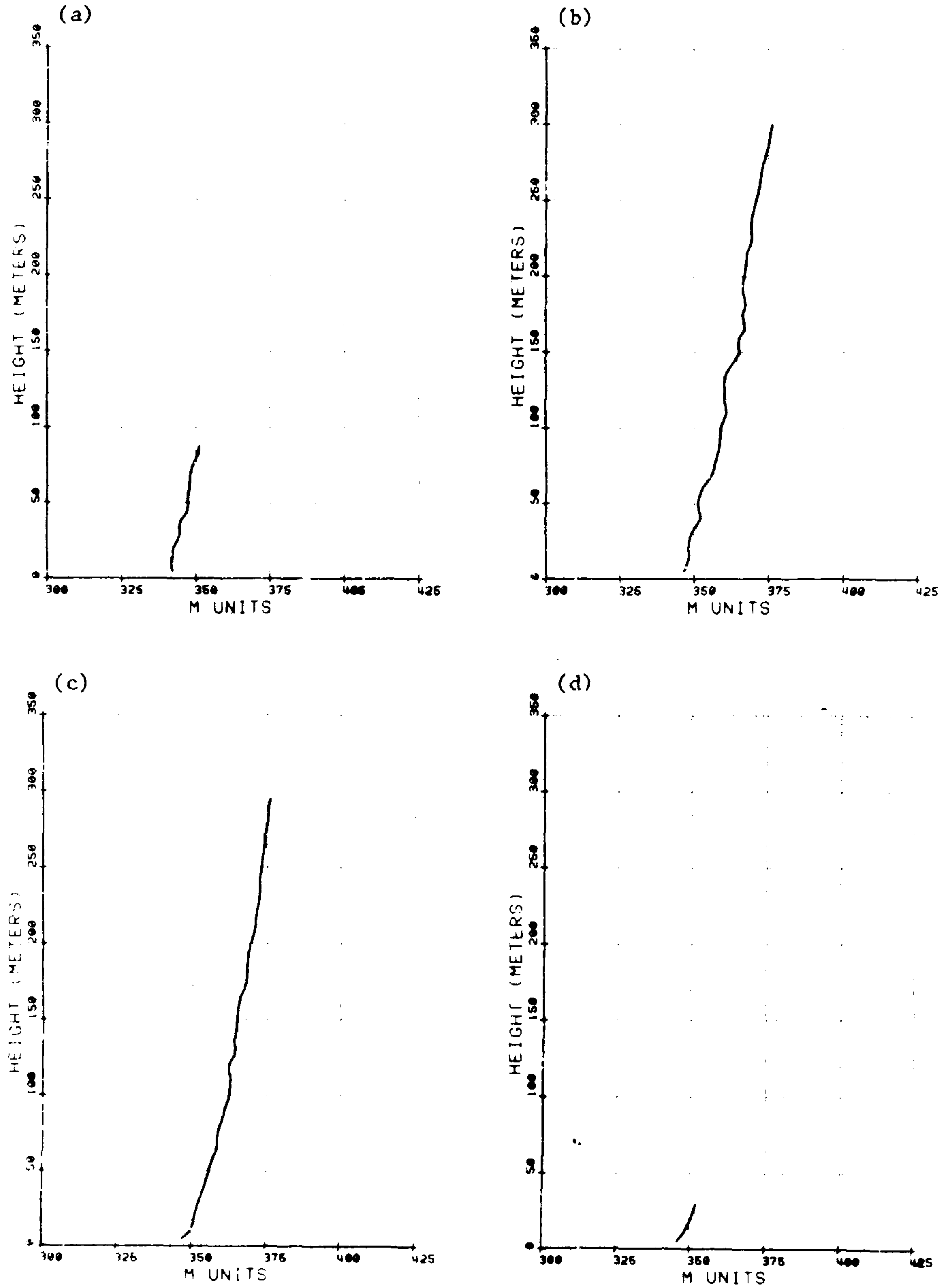


Figure 11-22 Case 11 M-Profiles: a. Apalachicola, 21 Nov 78, 1900Z; b. Apalachicola, 21 Nov 78, 2000Z; c. Apalachicola, 21 Nov 78, 2200Z; d. Apalachicola, 22 Nov 78, 0200Z.

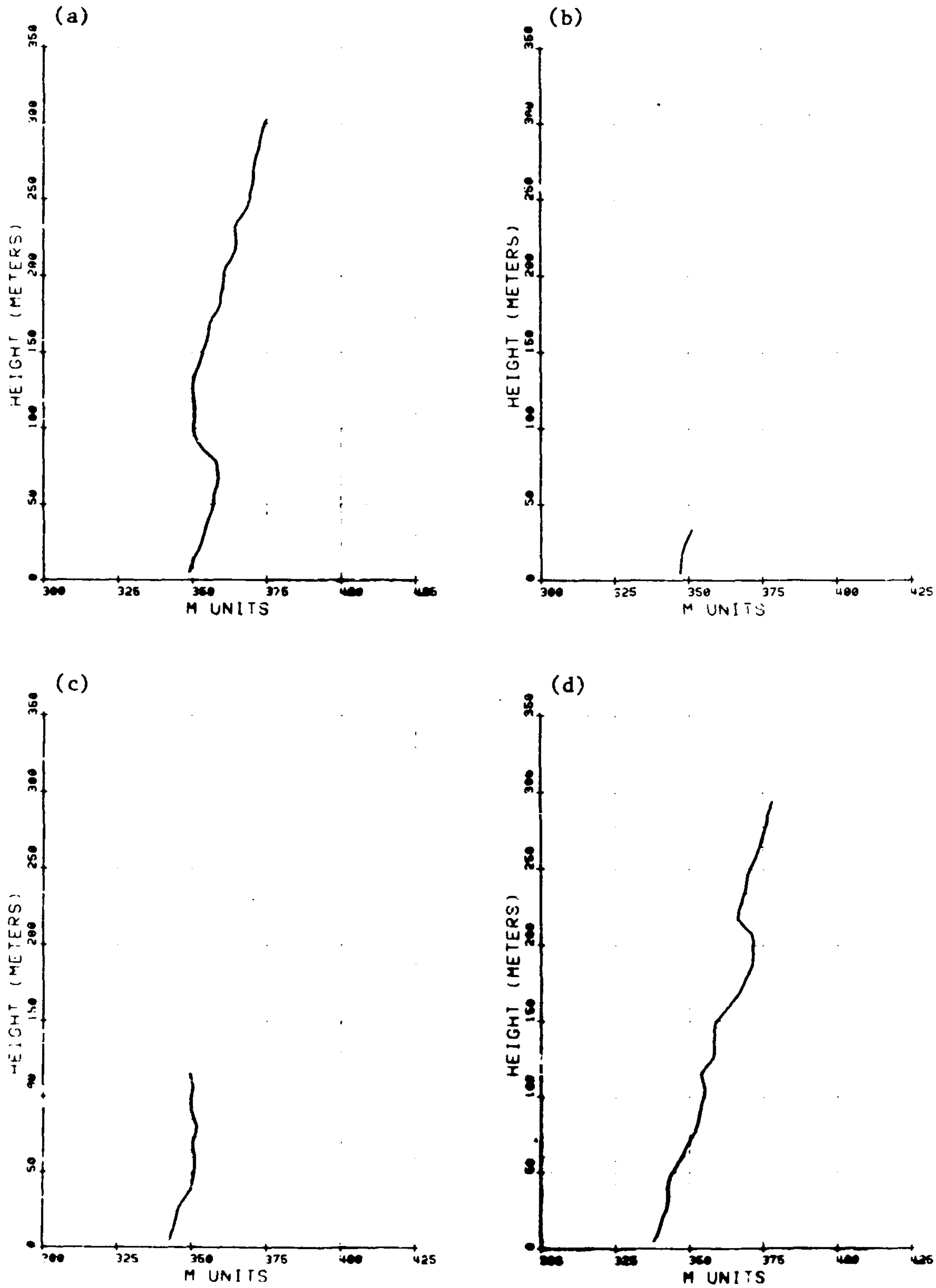


Figure 11-23 Case 11 M-Profiles: a. Apalachicola, 22 Nov 78, 0500Z; b. Apalachicola, 22 Nov 78, 0600Z; c. Apalachicola, 22 Nov 78, 0700Z; d. Apalachicola, 22 Nov 78, 1400Z.

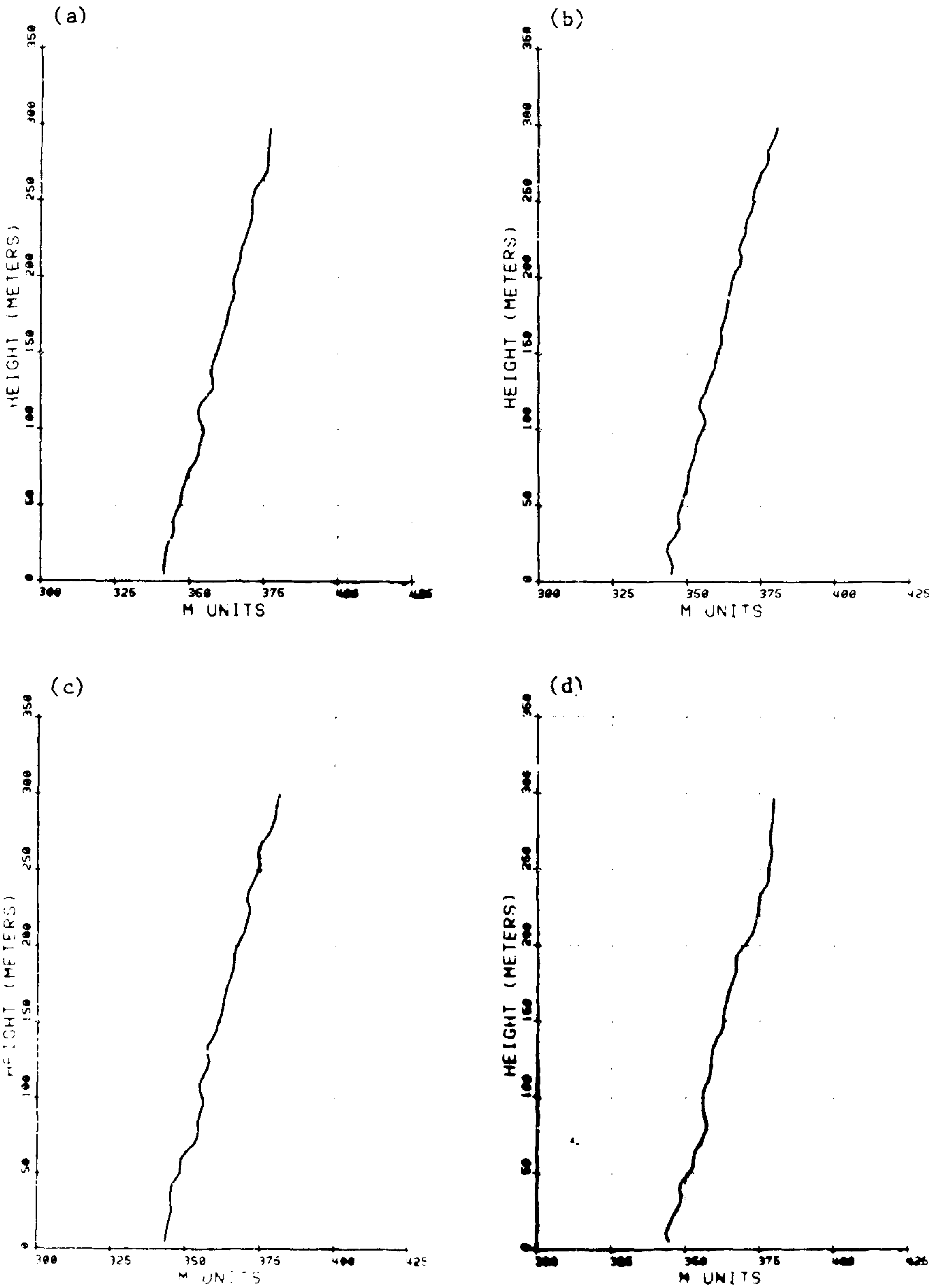


Figure 11-24 Case 11 M-Profiles: a. Apalachicola, 22 Nov 78, 1500Z; b. Apalachicola, 22 Nov 78, 1600Z; c. Apalachicola, 22 Nov 78, 1700Z; d. Apalachicola, 22 Nov 78, 1800Z.

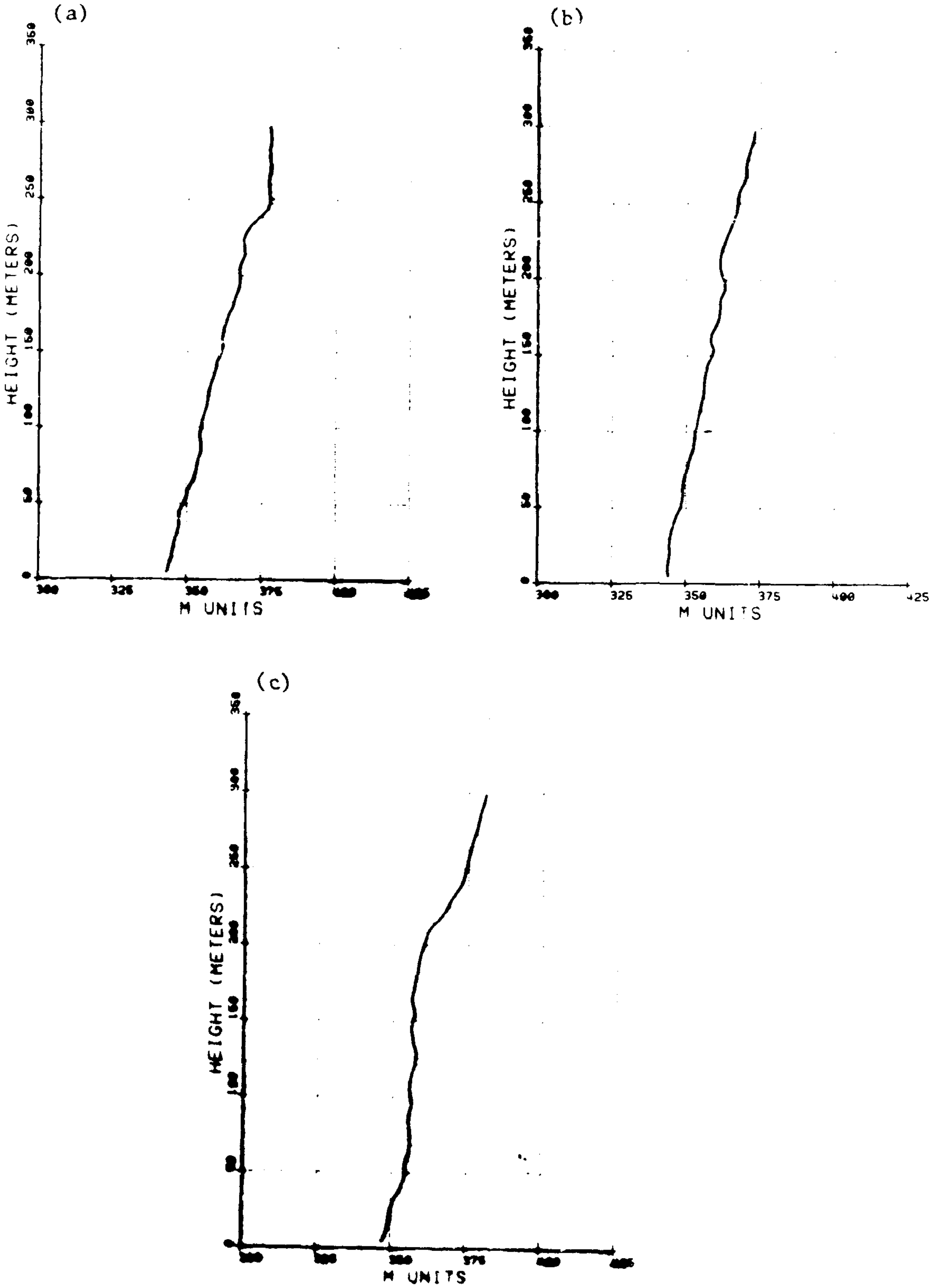


Figure 11-25 Case 11 M-Profiles : a. Apalachicola, 22 Nov 78, 1900Z; b. Apalachicola, 22 Nov 78, 2000Z; c. Apalachicola, 22 Nov 78, [illegible].

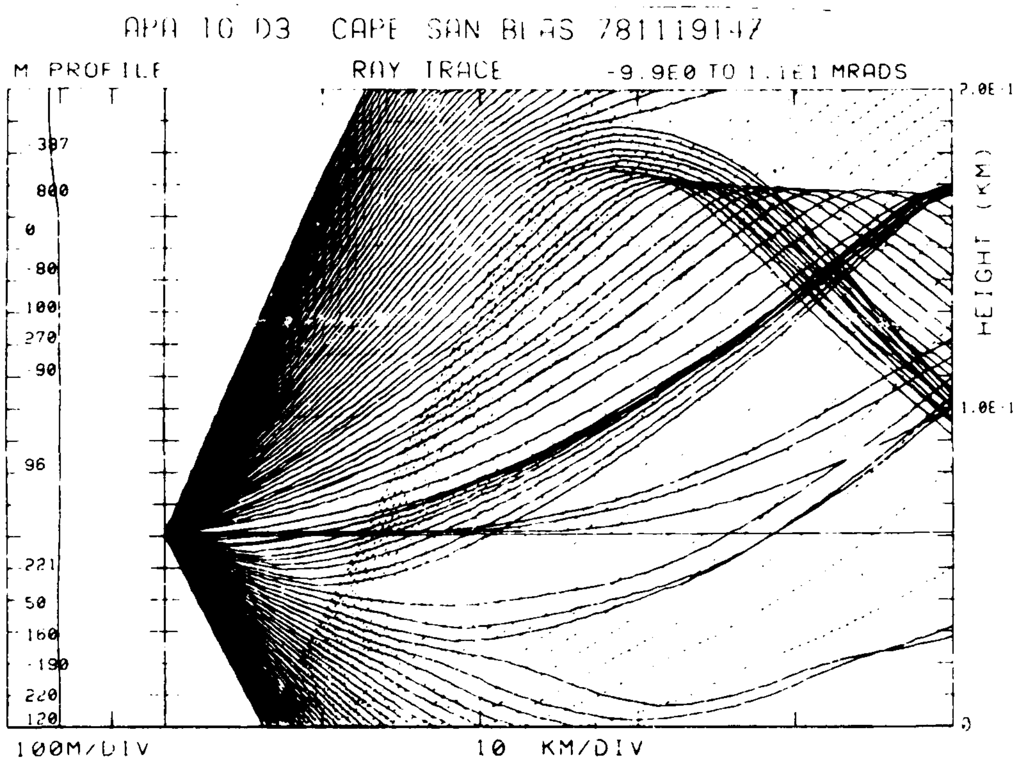


Figure 11-26. Case 11 Raytrace, APA to D3, Cape San Blas 19 Nov 78, 1400Z, Transmitter Height 61.0 m.

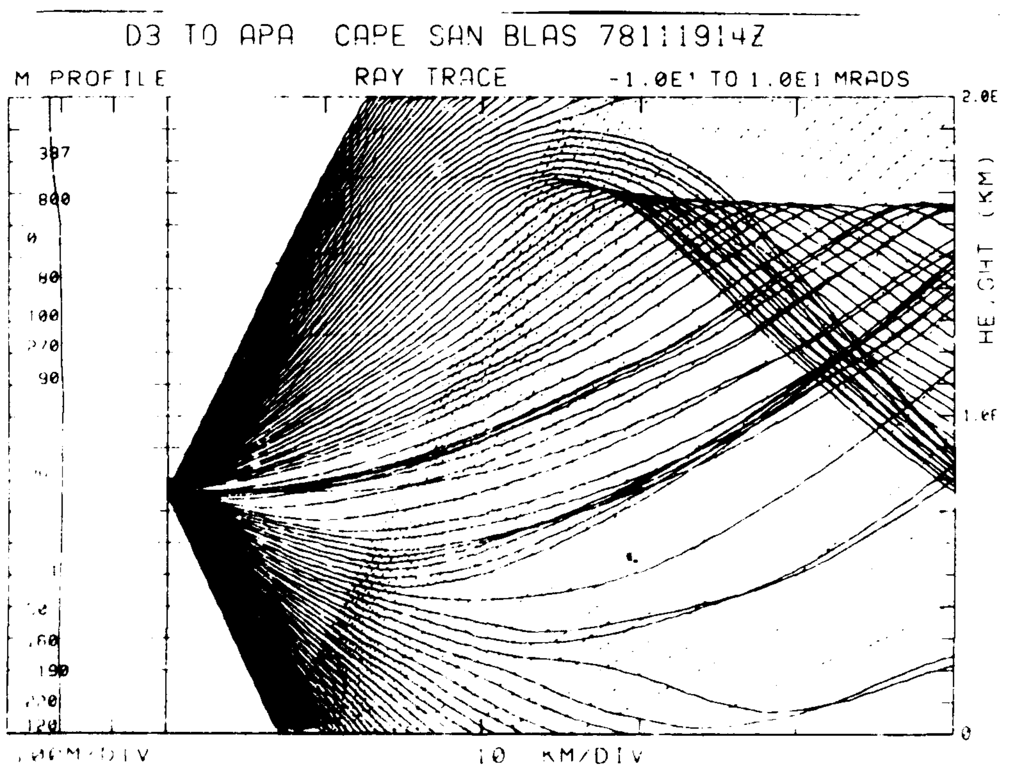


Figure 11-27. Case 11 Raytrace, D3 to APA, Cape San Blas 19 Nov 78, 1400Z, Transmitter Height 76.2 m.

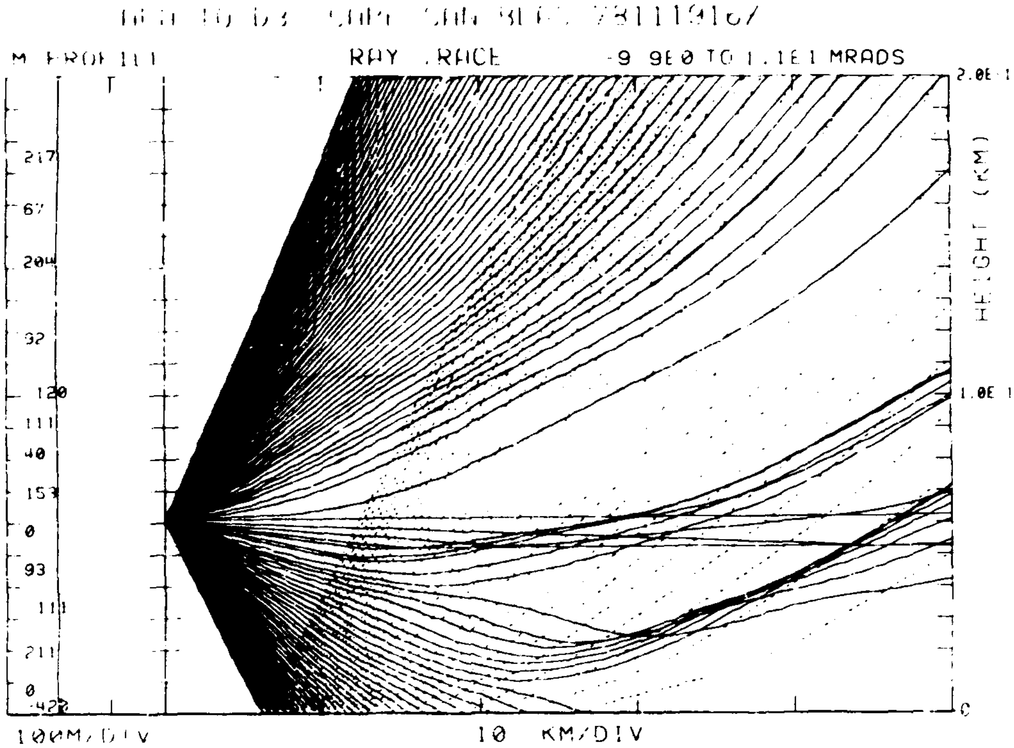


Figure 11-28. Case 11 Raytrace, APA to D3, Cape San Blas 19 Nov 78, 1600Z, Transmitter Height, 61.0 m.

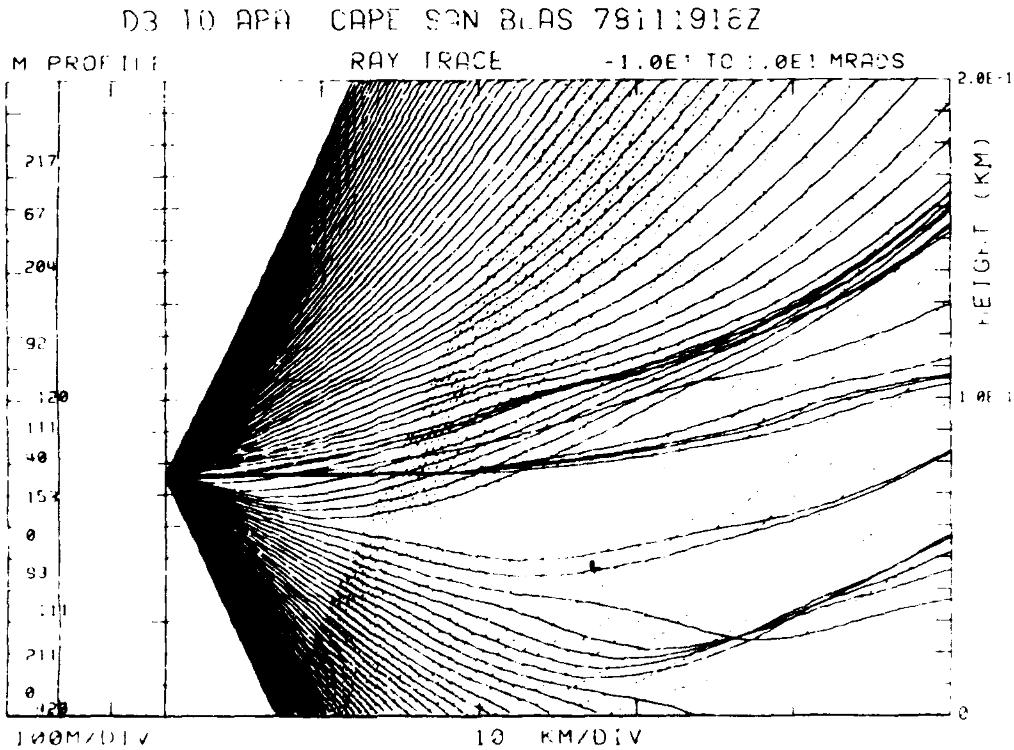


Figure 11-29. Case 11 Raytrace, D3 to APA, Cape San Blas 19 Nov 78, 1600Z, Transmitter Height, 76.2 m.

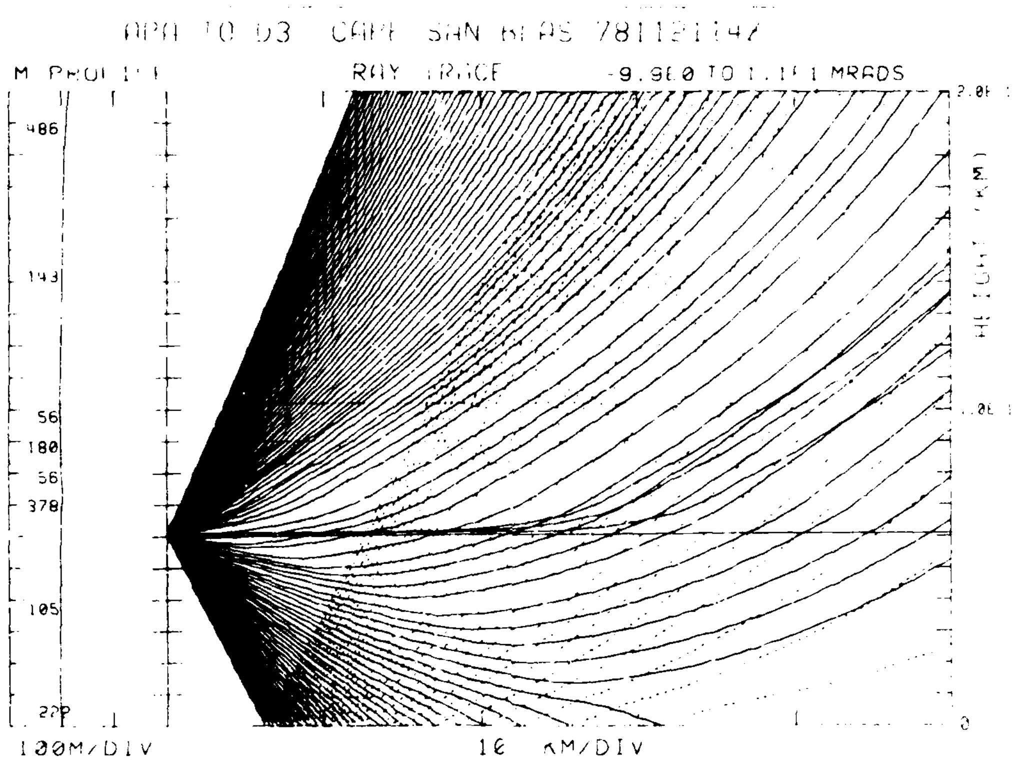


Figure 11-30. Case 11 Raytrace, APA to D3, Cape San Blas 21 Nov 78, 1400Z, Transmitter Height 61.0 m.

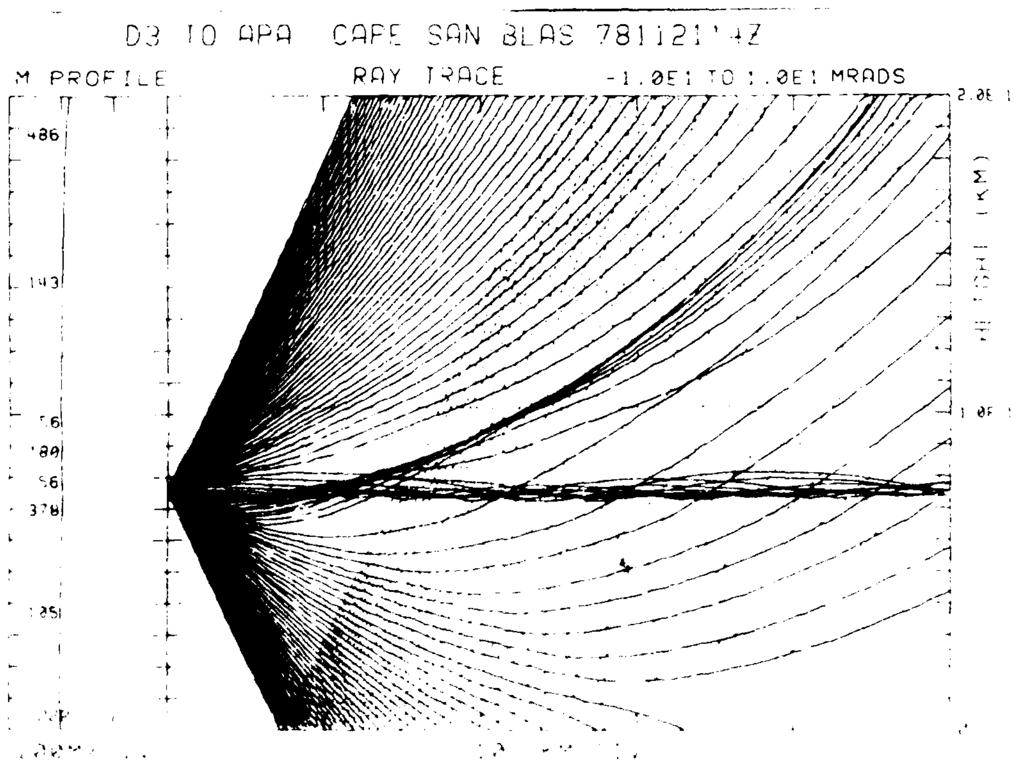


Figure 11-31. Case 11 Raytrace, D3 to APA, Cape San Blas 21 Nov 78, 1400Z, Transmitter Height 76.2 m.

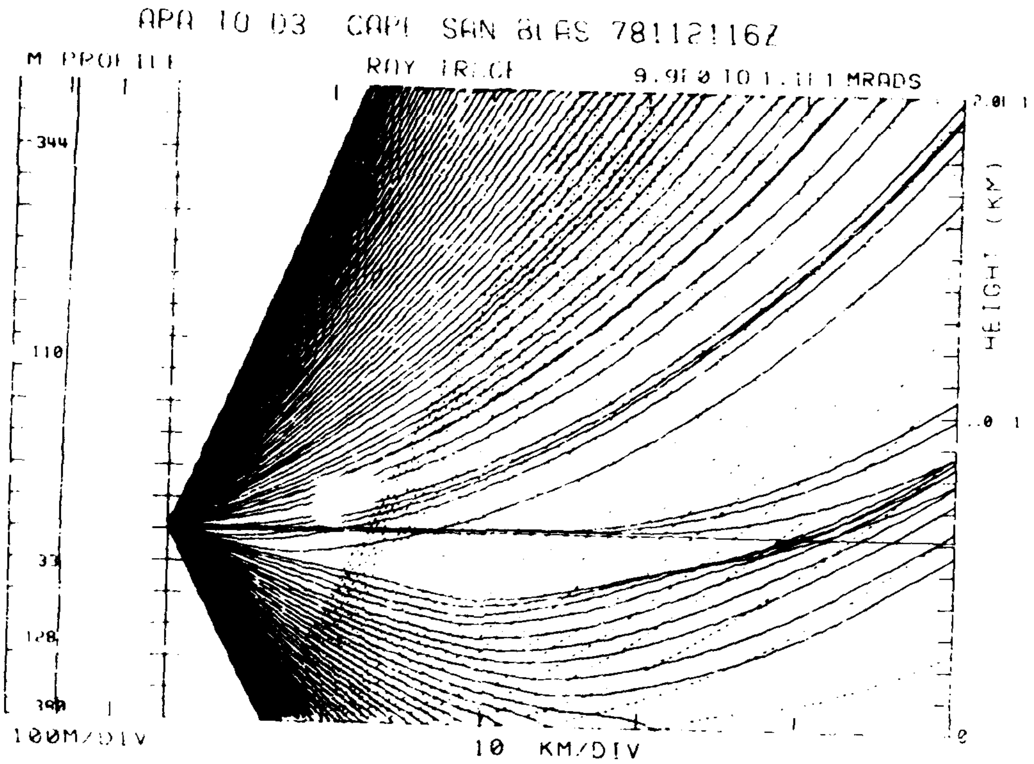


Figure 11-32. Case 11 Raytrace, APA to D3, Cape San Blas 21 Nov 78, 1600Z, Transmitter Height 61.0 m.

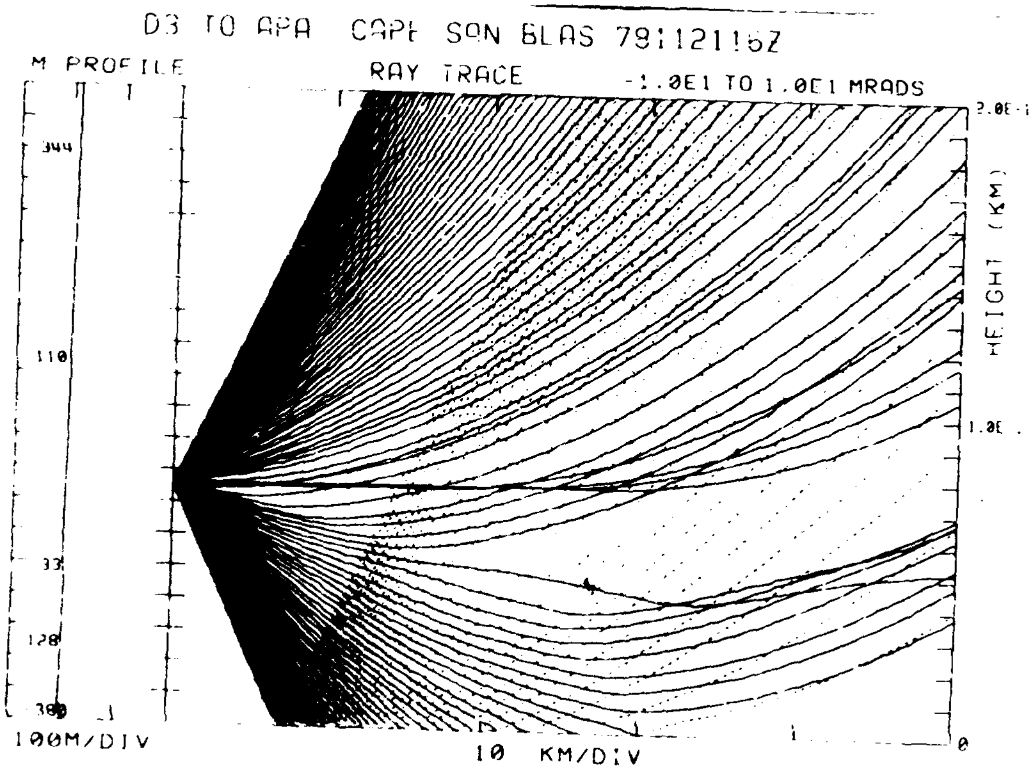


Figure 11-33. Case 11 Raytrace, D3 to APA, Cape San Blas 21 Nov 78, 1600Z, Transmitter Height 76.2 m.

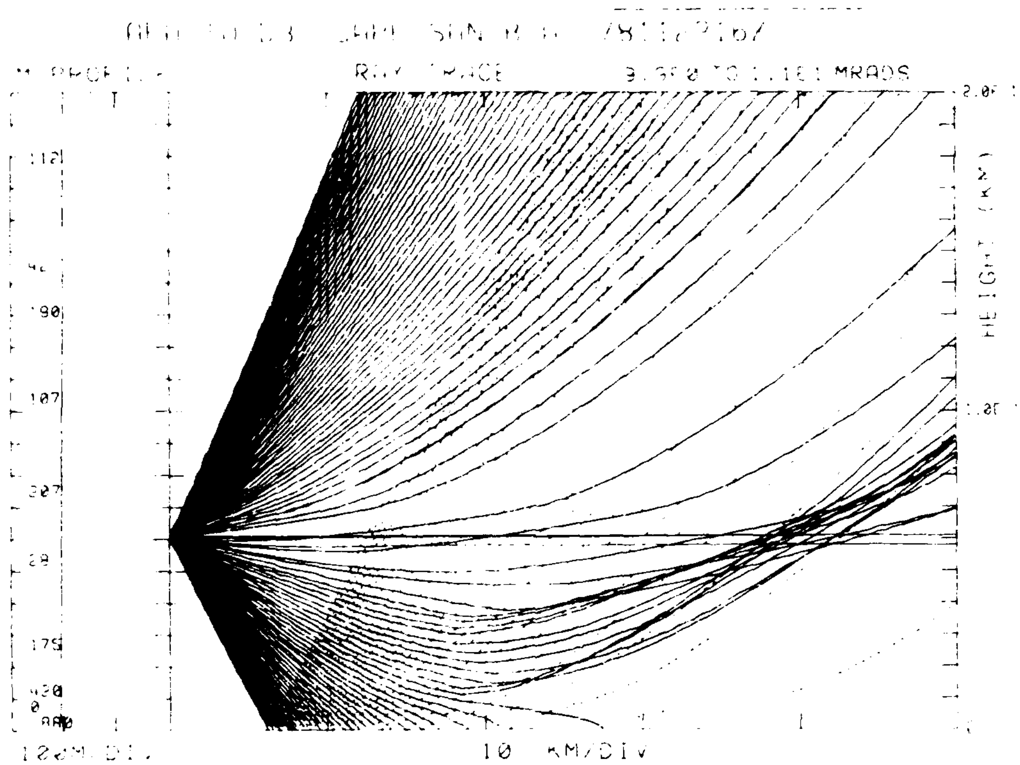


Figure 11-34. Case 11 Raytrace, APA to D3, Cape San Blas
22 Nov 78, 1600Z, Transmitter Height 61.0 m.

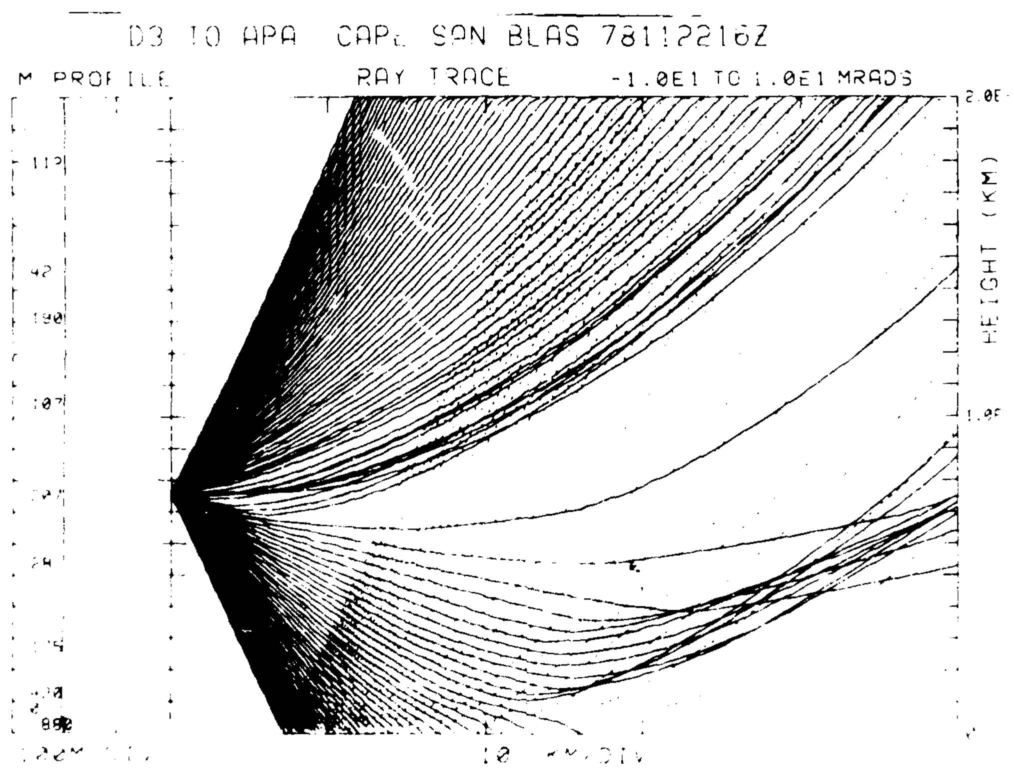


Figure 11-35. Case 11 Raytrace, D3 to APA, Cape San Blas
22 Nov 78, 1600Z, Transmitter Height 76.2 m.

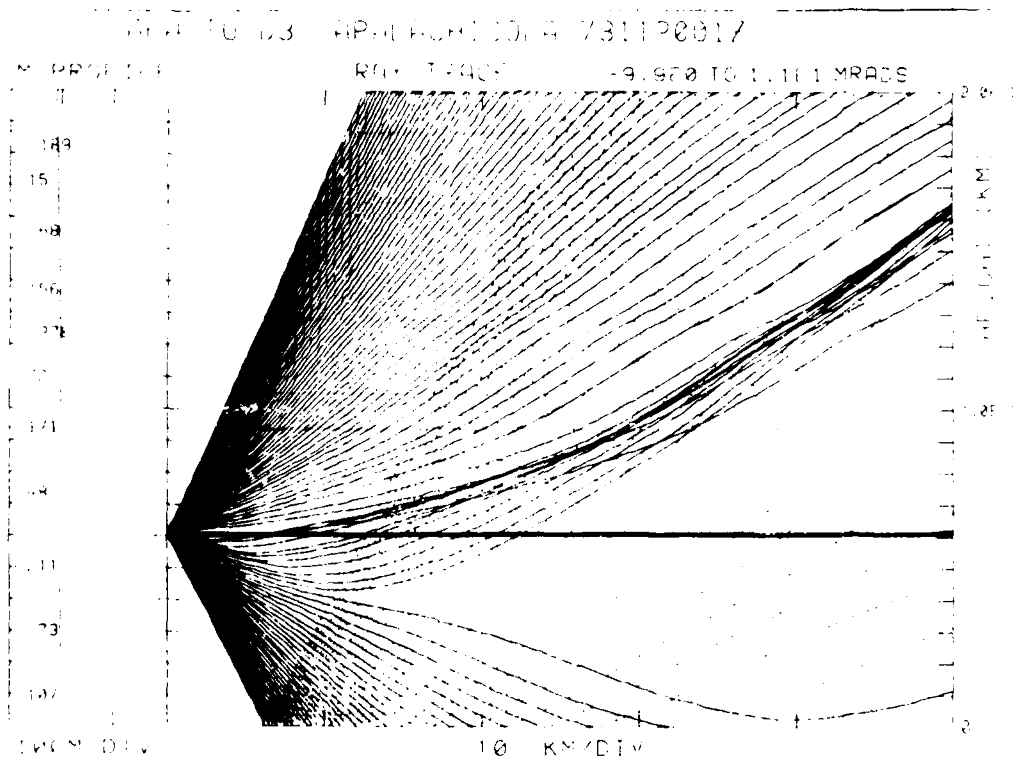


Figure 11-36. Case 11 Raytrace, APA to D3, Apalachicola 20 Nov 78, 0100Z, Transmitter Height 61.0 m.

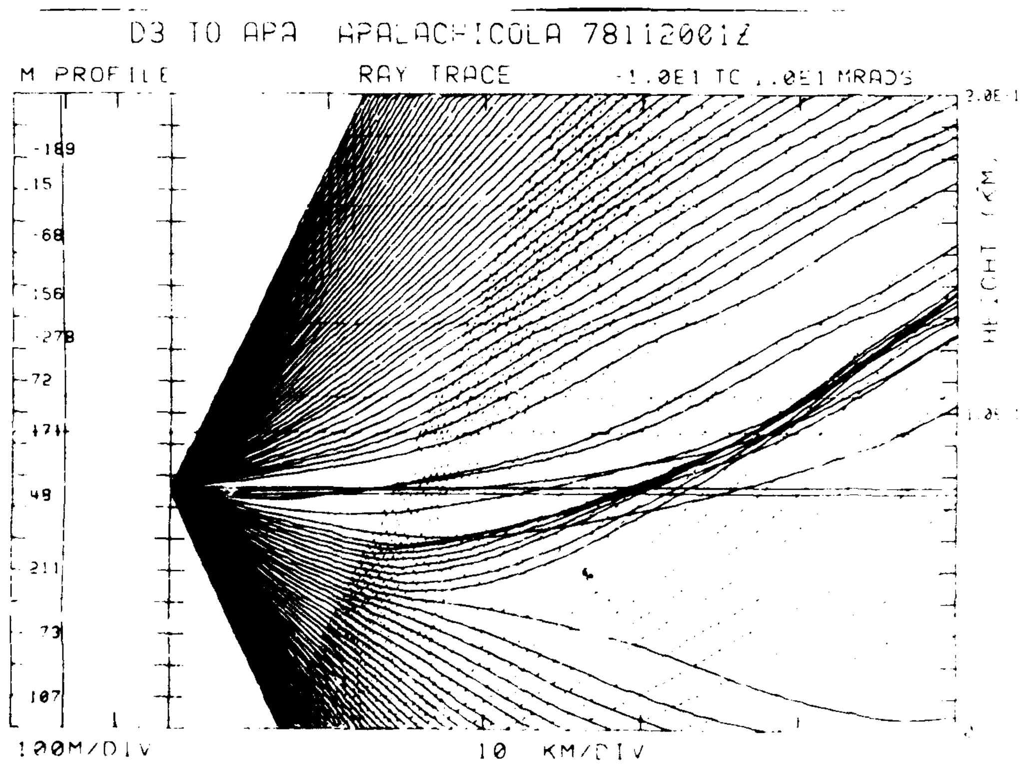


Figure 11-37. Case 11 Raytrace, D3 to APA, Apalachicola 20 Nov 78, 0100Z, Transmitter Height 76.2 m.

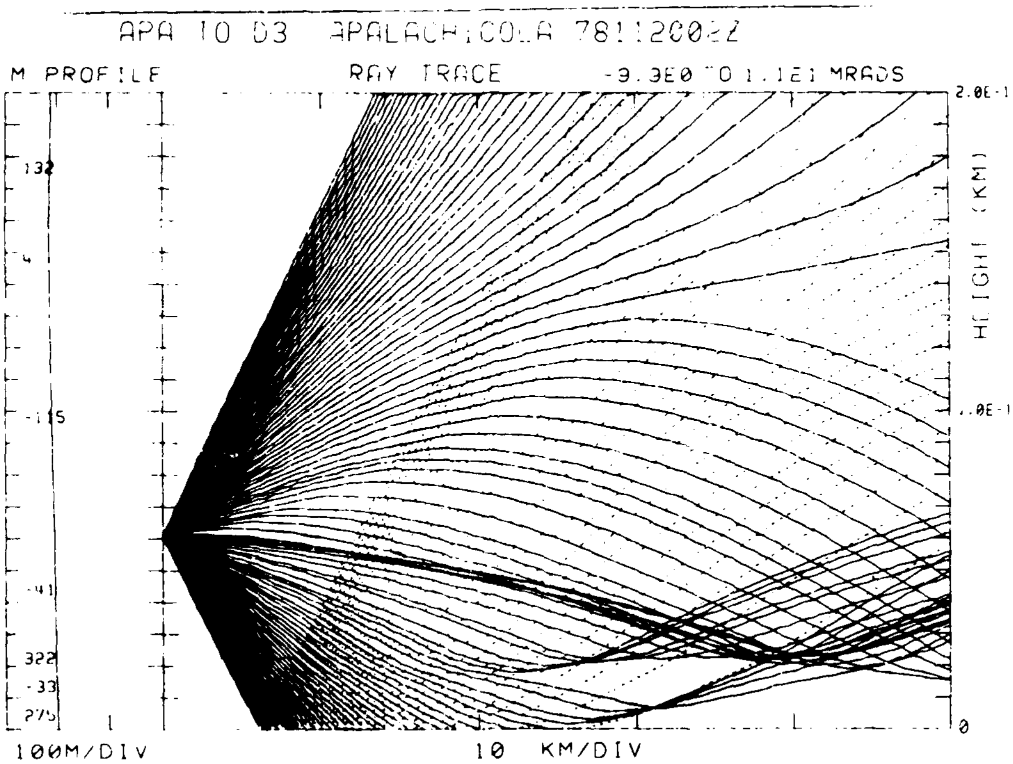


Figure 11-38. Case 11 Raytrace, APA to D3, Apalachicola 20 Nov 78, 0200Z, Transmitter Height 61.0 m.

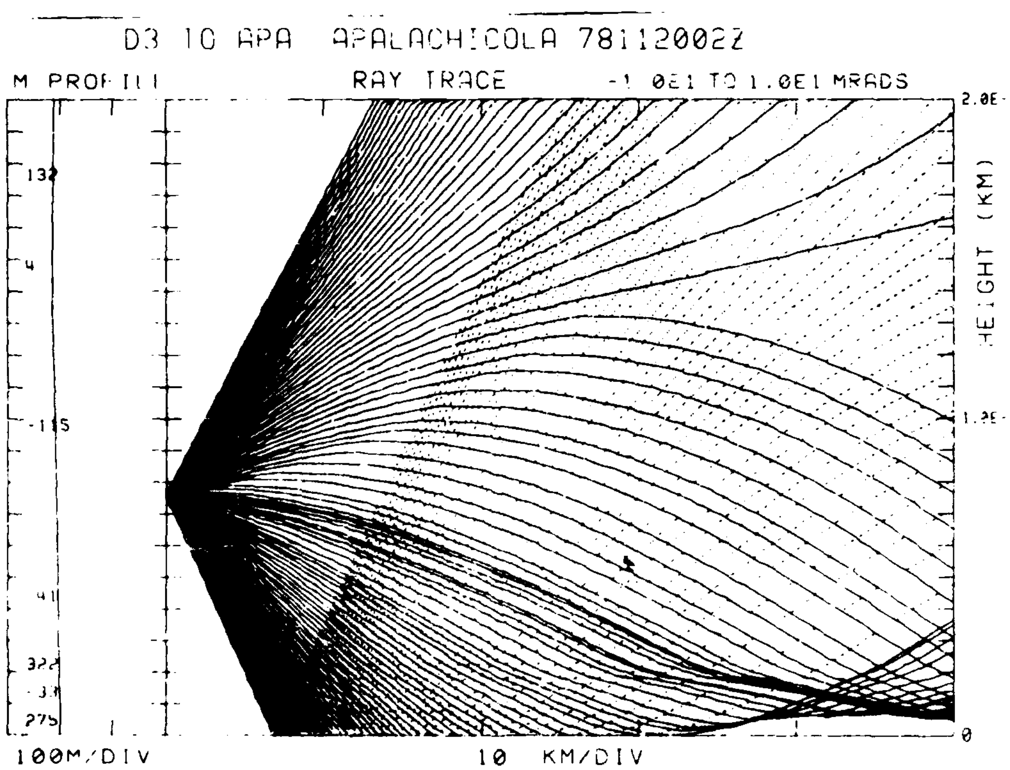


Figure 11-39. Case 11 Raytrace, D3 to APA, Apalachicola 20 Nov 78, 0200Z, Transmitter Height 76.2 m.

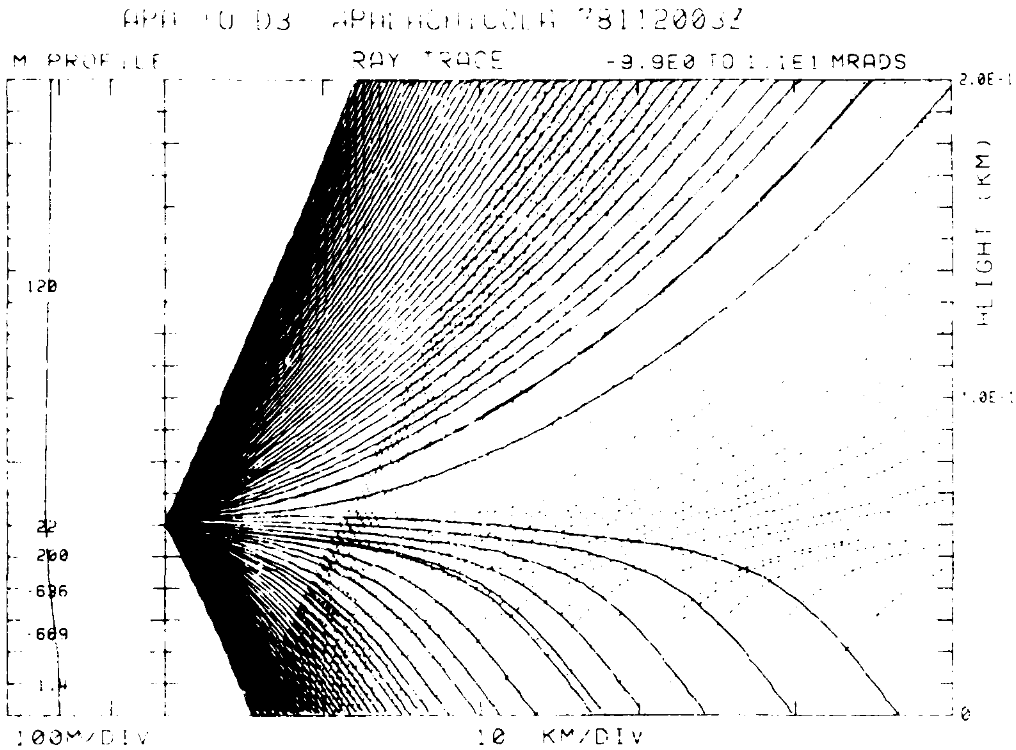


Figure 11-40. Case 11 Raytrace, APA to D3, Apalachicola 20 Nov 78, 0300Z, Transmitter Height 61.0 m.

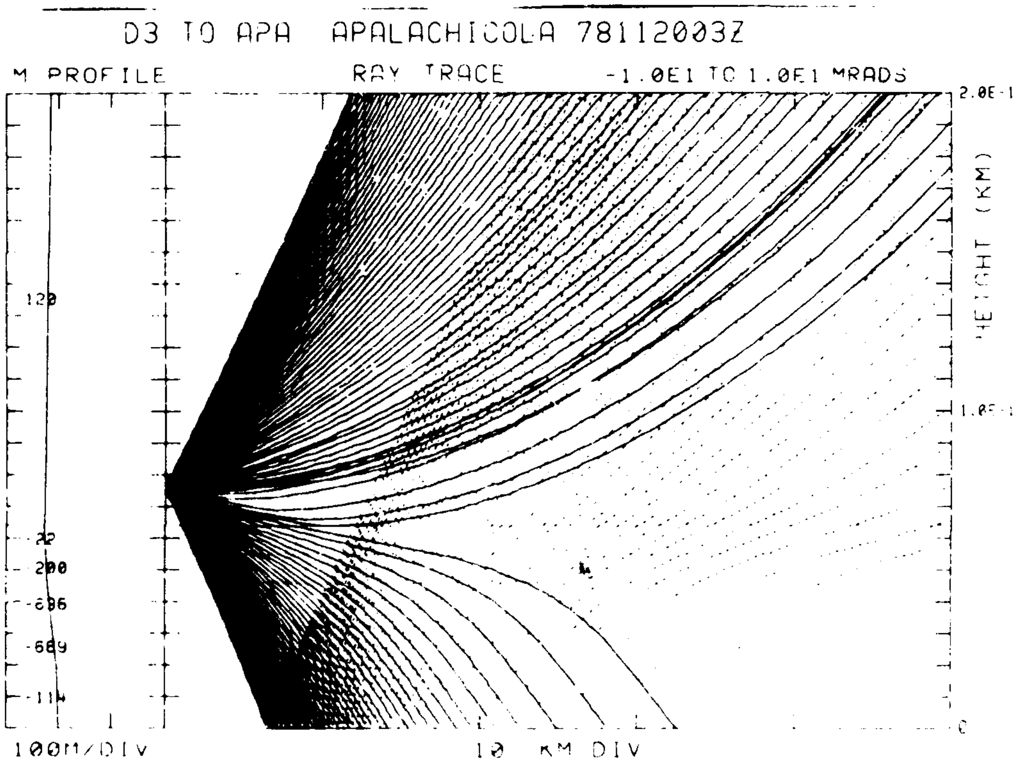


Figure 11-41. Case 11 Raytrace, D3 to APA, Apalachicola 20 Nov 78, 0300Z, Transmitter Height 76.2 m.

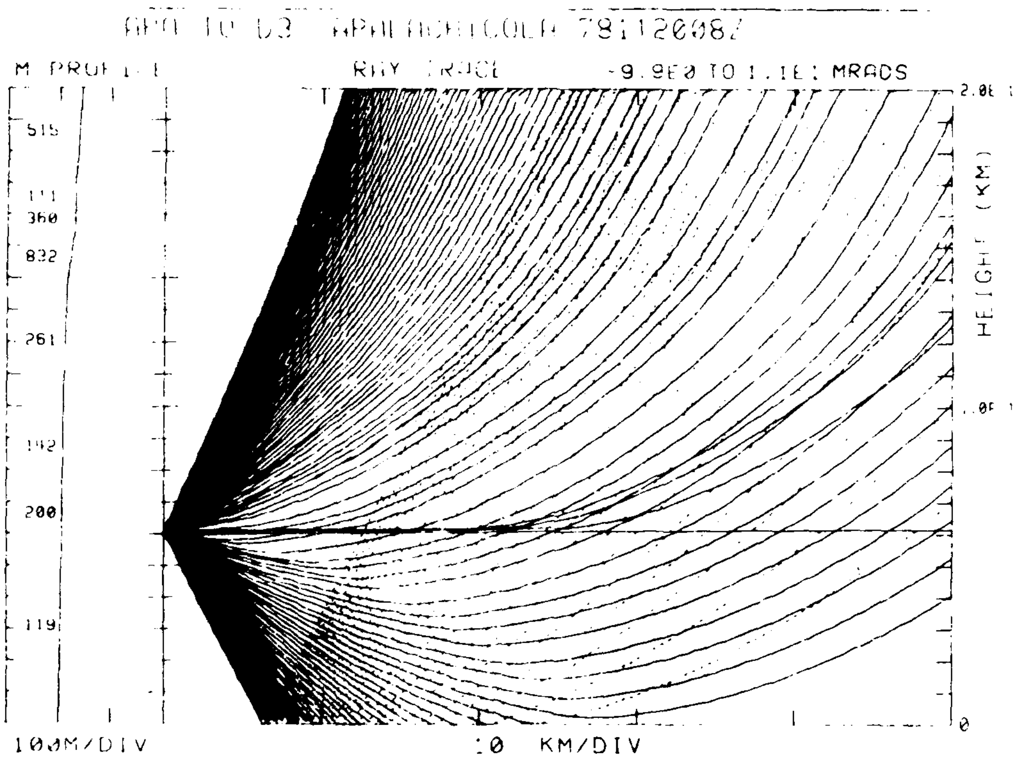


Figure 11-42. Case 11 Raytrace, APA to D3, Apalachicola 20 Nov 78, 0800Z, Transmitter Height 61.0 m.

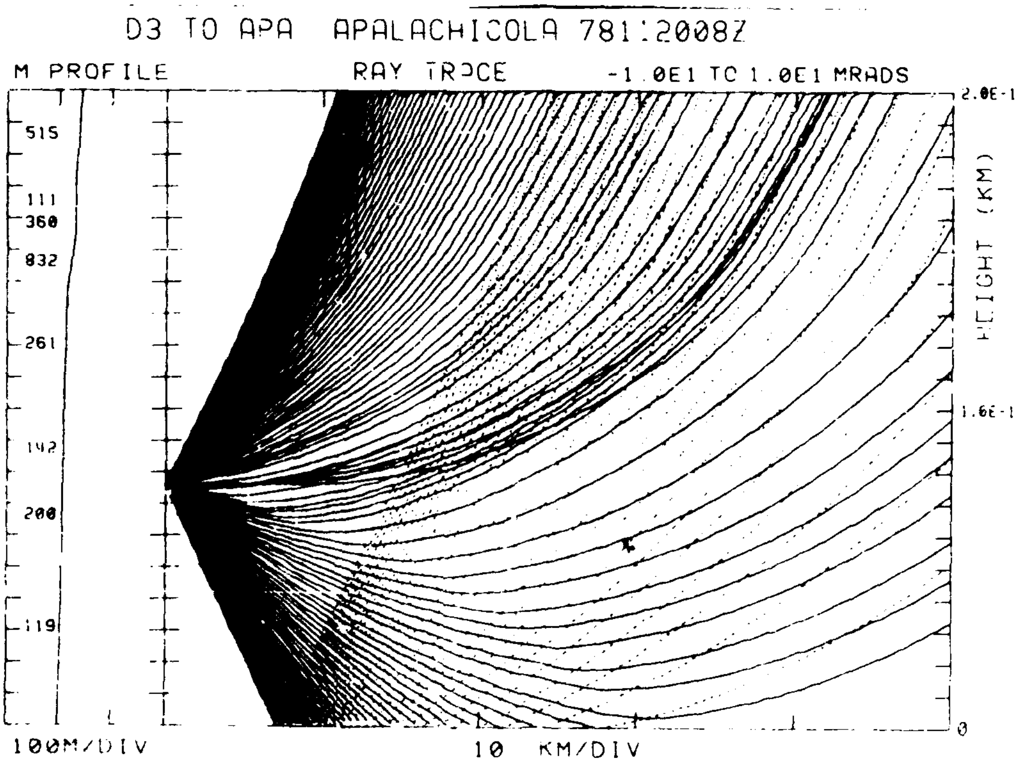


Figure 11-43. Case 11 Raytrace, D3 to APA, Apalachicola 20 Nov 78, 0800Z, Transmitter Height 76.2 m.

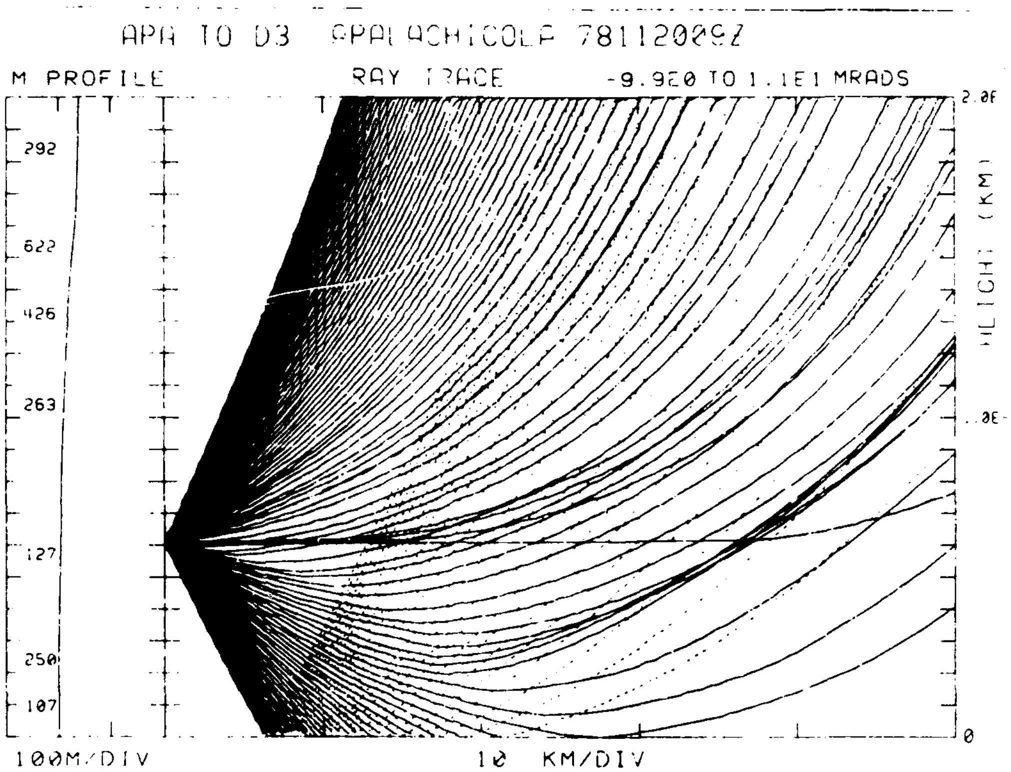


Figure 11-44. Case 11 Raytrace, APA to D3, Apalachicola 20 Nov 78, 0900Z, Transmitter Height 61.0 m.

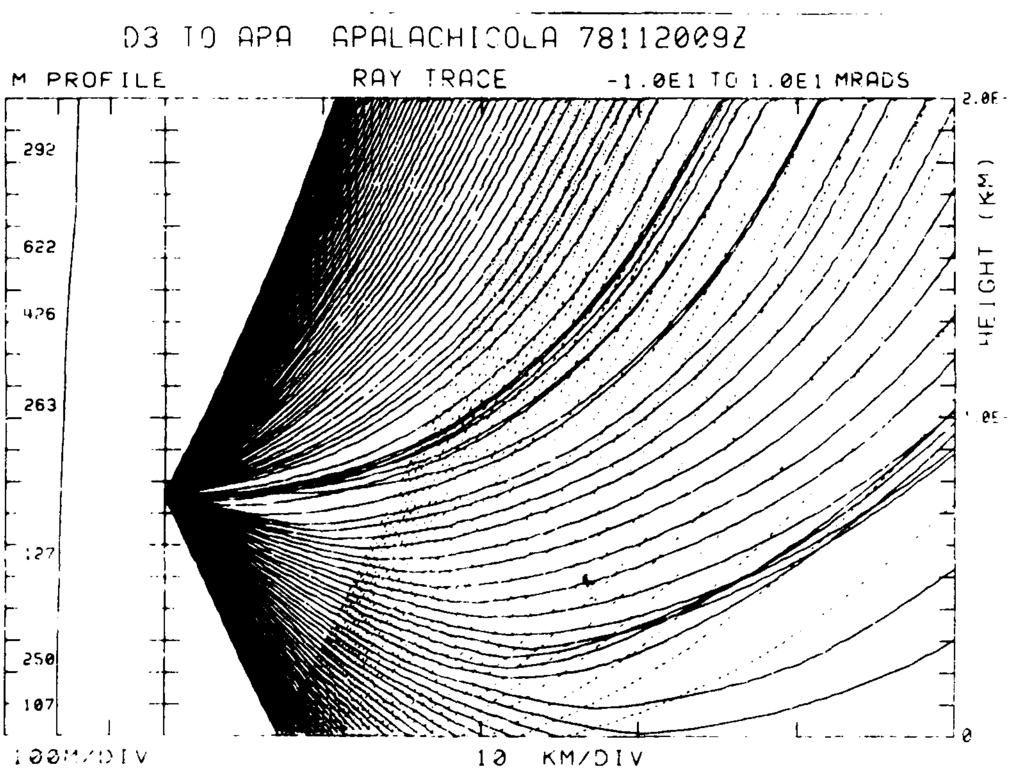


Figure 11-45. Case 11 Raytrace, D3 to APA, Apalachicola 20 Nov 78, 0900Z, Transmitter Height 76.2 m.

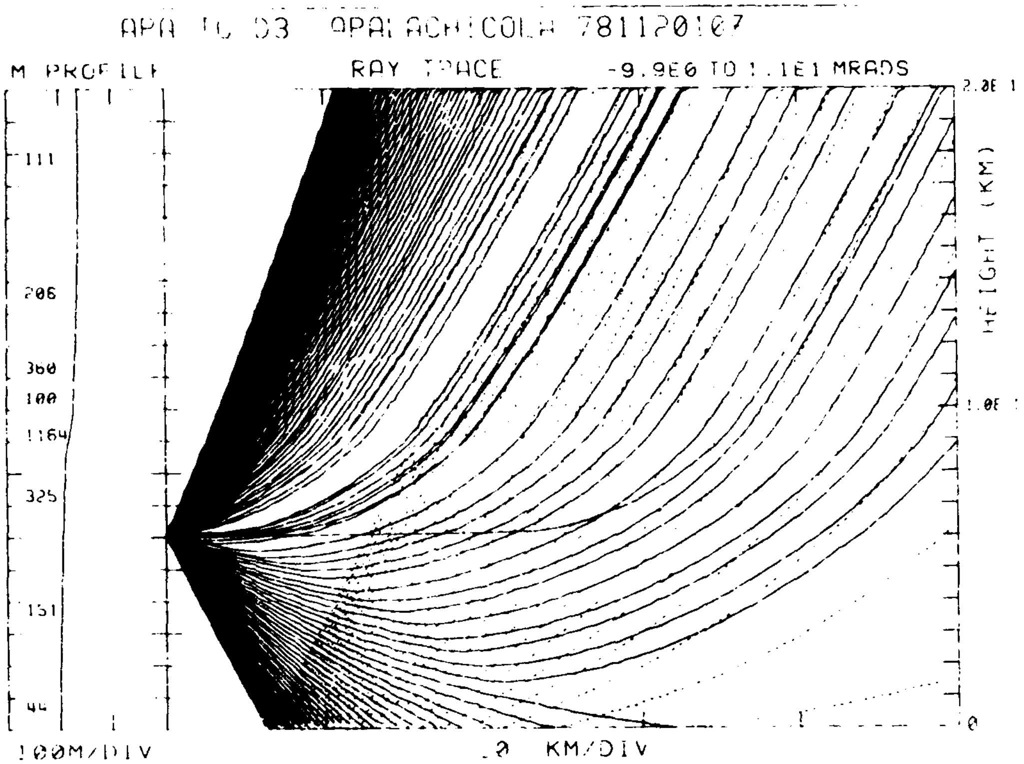


Figure 11-46. Case 11 Raytrace, APA to D3, Apalachicola 20 Nov 78, 1000Z, Transmitter Height 61.0 m.

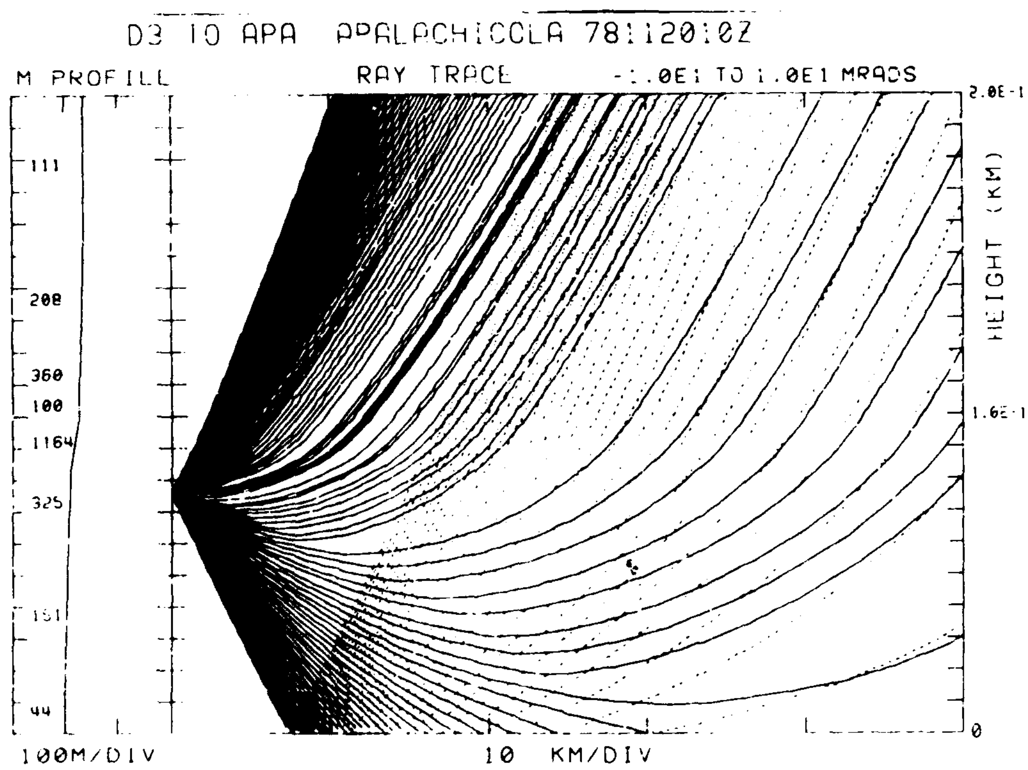


Figure 11-47. Case 11 Raytrace, D3 to APA, Apalachicola 20 Nov 78, 1000Z, Transmitter Height 76.2 m.

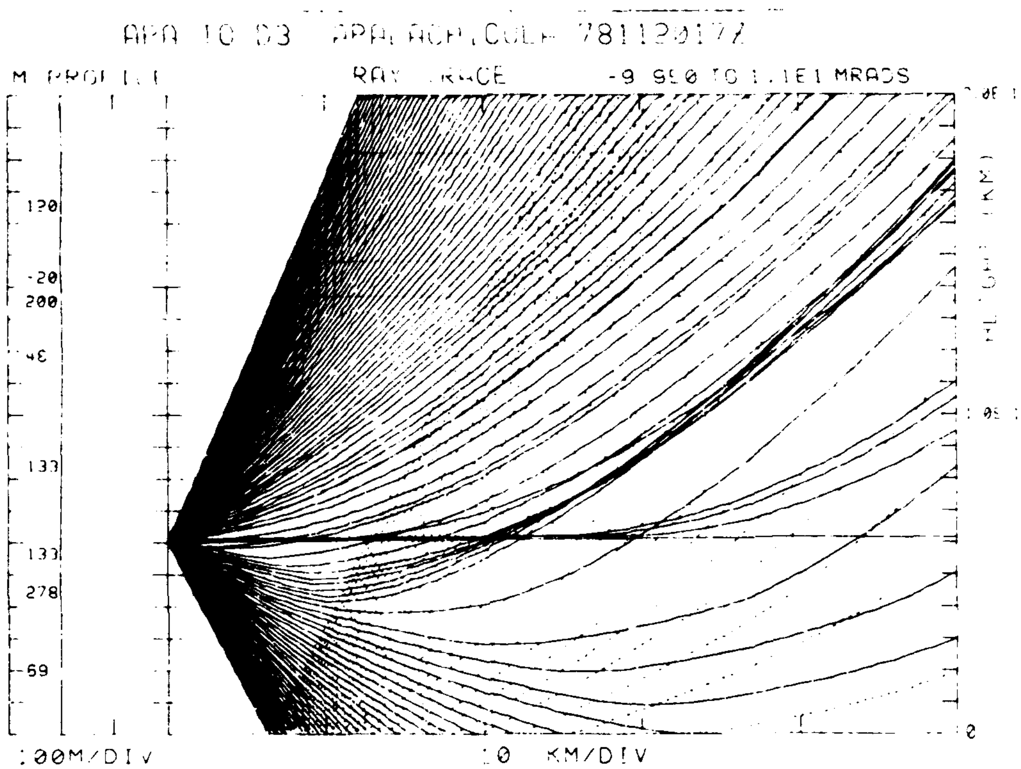


Figure 11-48. Case 11 Raytrace, APA to D3, Apalachicola 20 Nov 78, 1700Z, Transmitter Height 61.0 m.

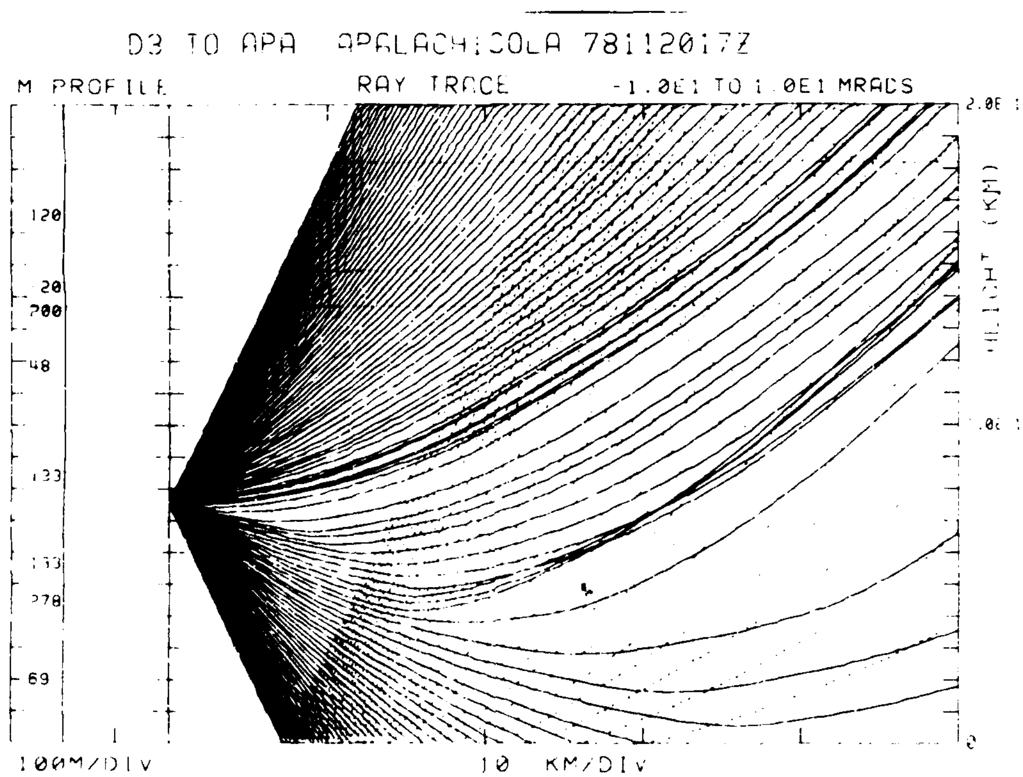


Figure 11-49. Case 11 Raytrace, D3 to APA, Apalachicola 20 Nov 78, 1700Z, Transmitter Height, 76.2 m.

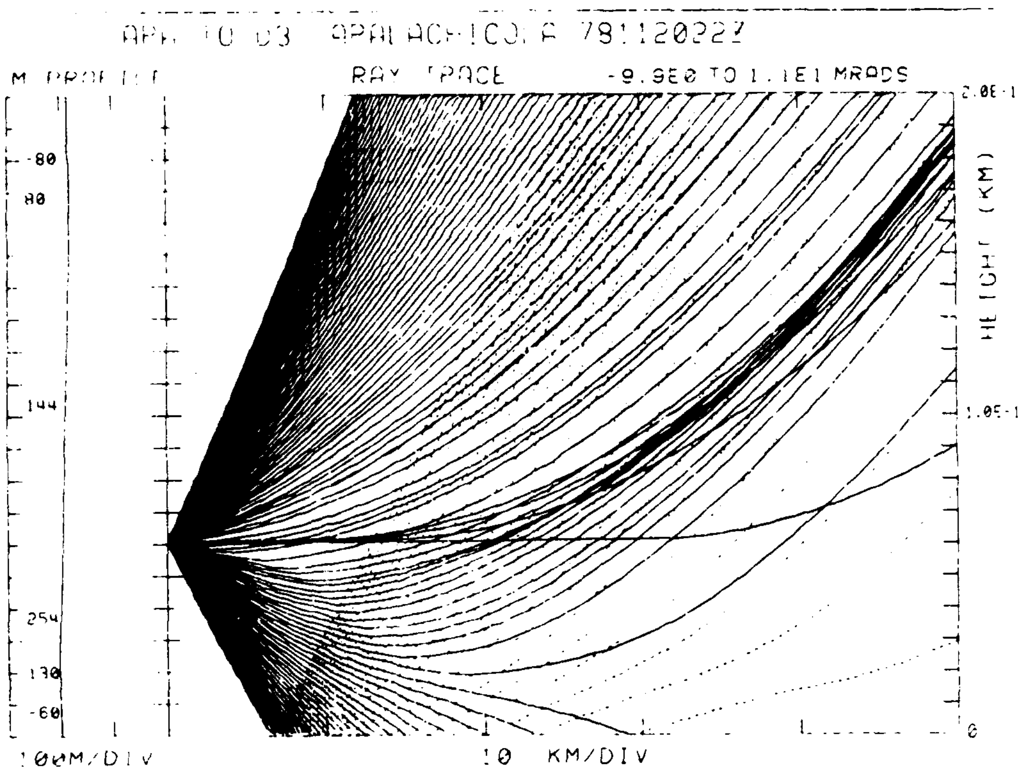


Figure 11-50. Case 11 Raytrace, APA to D3, Apalachicola 20 Nov 78, 2200Z, Transmitter Height 61.0 m.

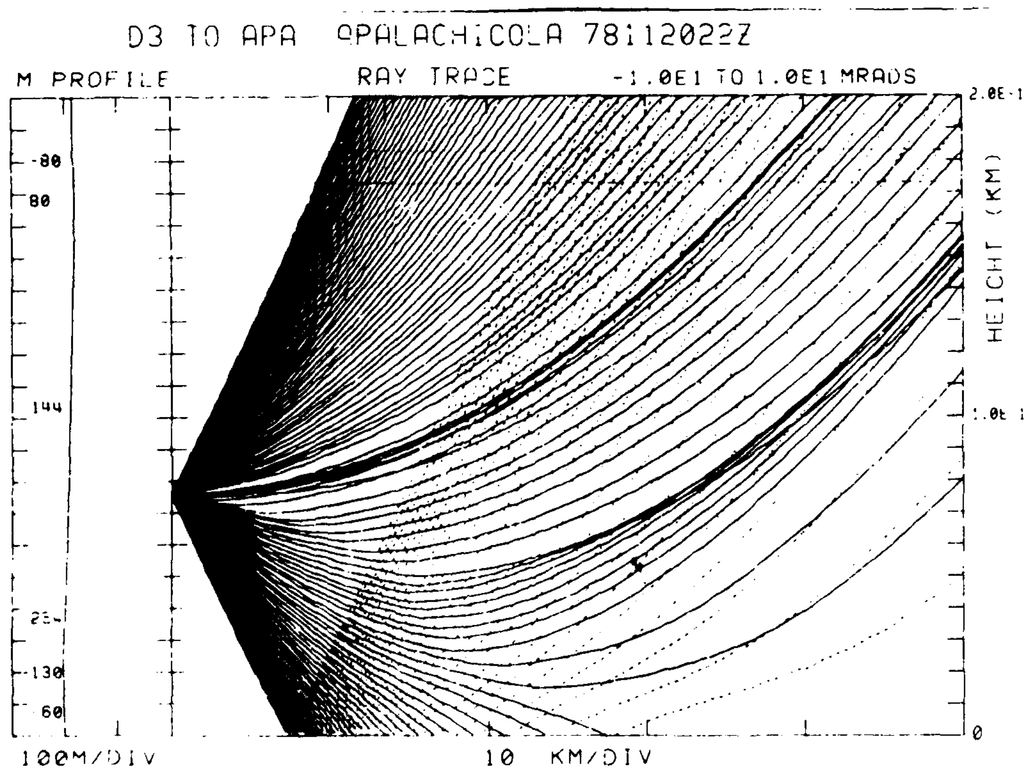


Figure 11-51. Case 11 Raytrace, D3 to APA, Apalachicola 20 Nov 78, 2200Z, Transmitter Height 76.2 m.

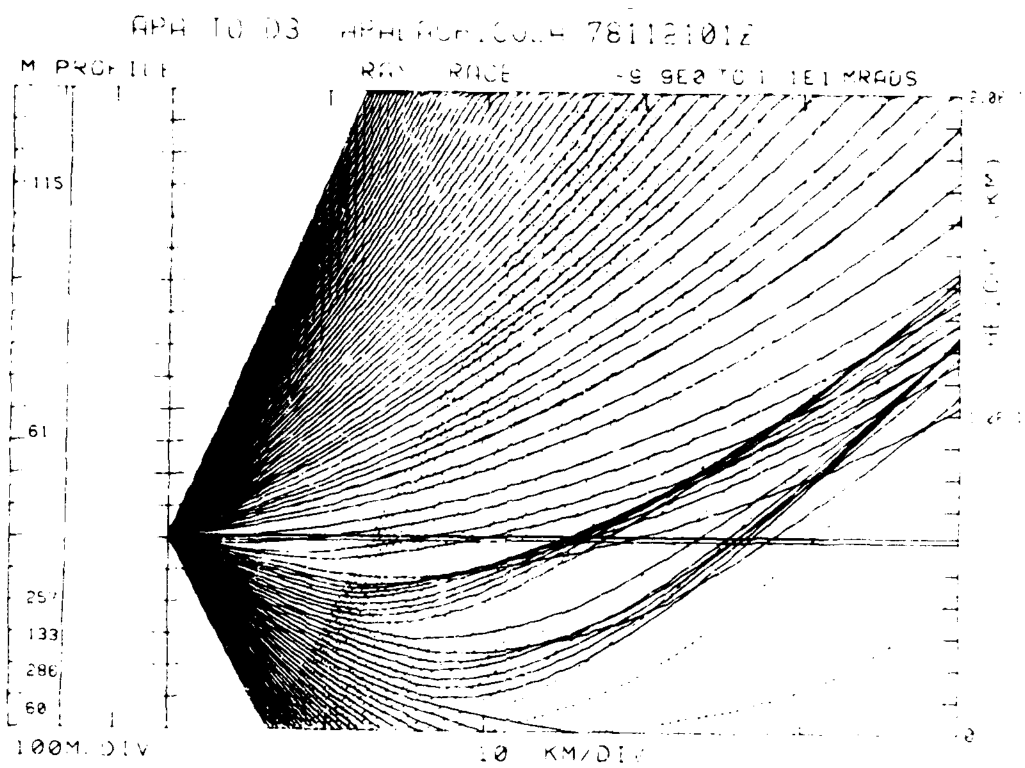


Figure 11-52. Case 11 Raytrace, APA to D3, Apalachicola 21 Nov 78, 0100Z, Transmitter Height 61.0 m.

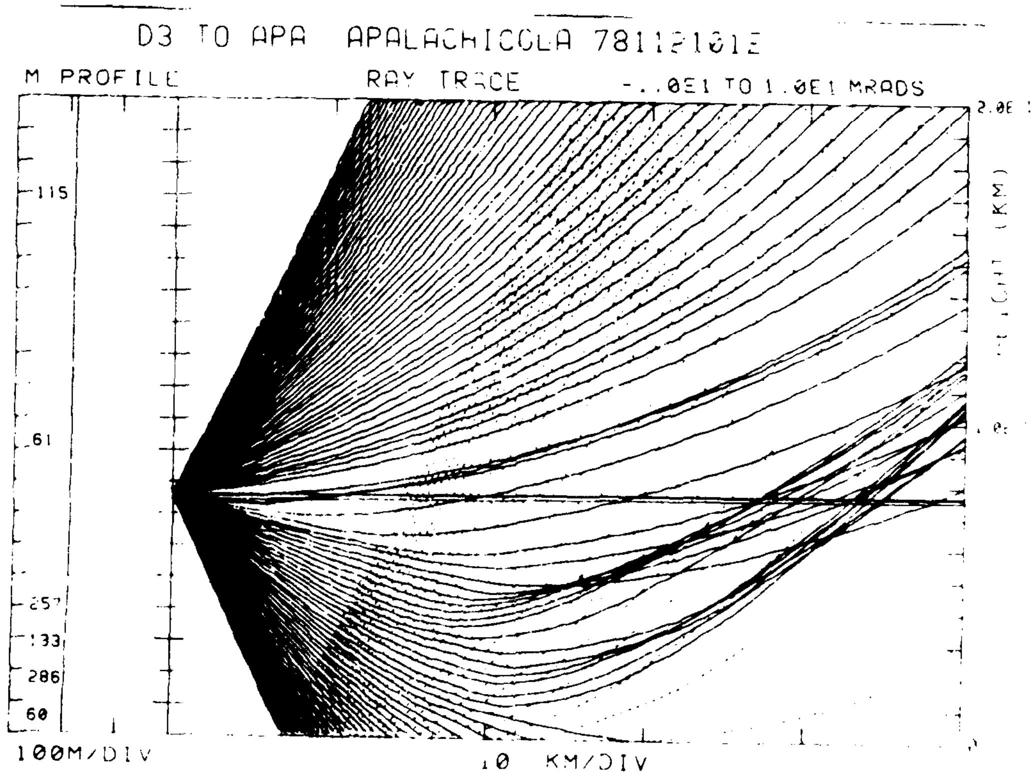


Figure 11-53. Case 11 Raytrace, D3 to APA, Apalachicola 21 Nov 78, 0100Z, Transmitter Height 76 2 m.

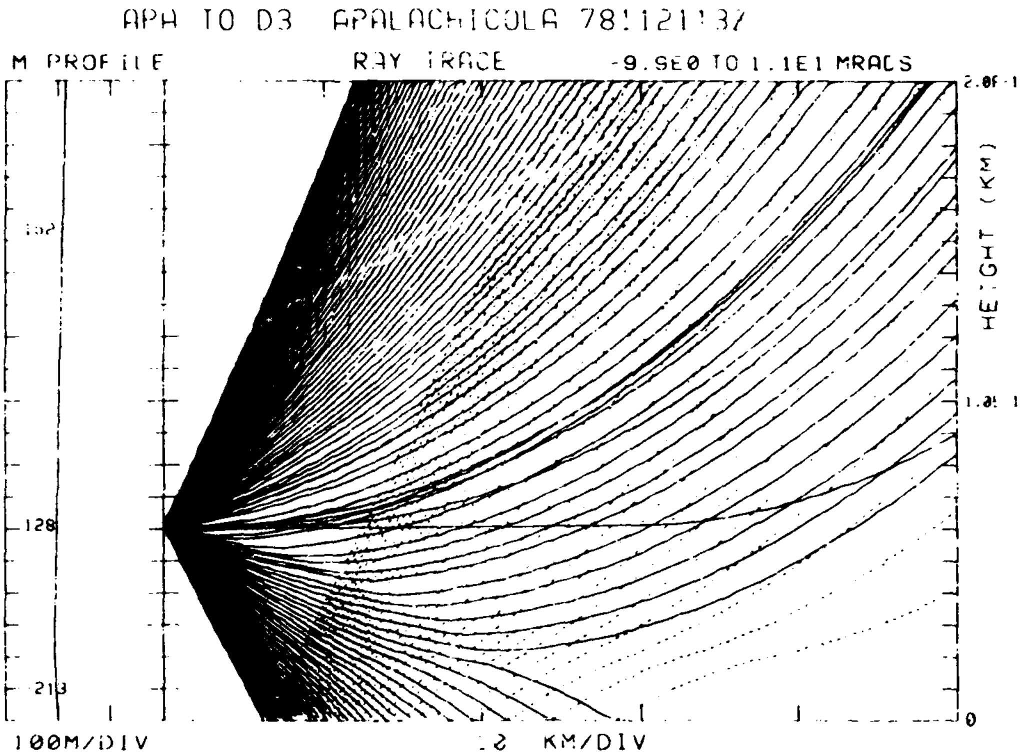


Figure 11-54. Case 11 Raytrace, APA to D3, Apalachicola 21 Nov 78, 1300Z, Transmitter Height 61.0 m.

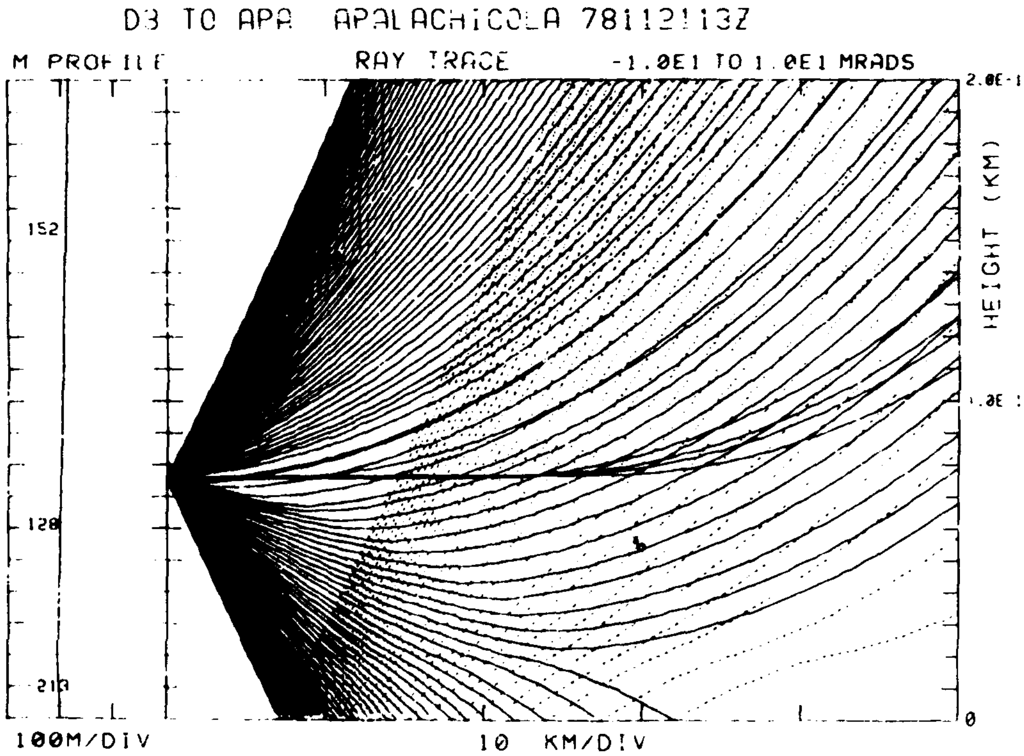


Figure 11-55. Case 11 Raytrace, D3 to APA, Apalachicola 21 Nov 78 1300Z, Transmitter Height 76.2 m.

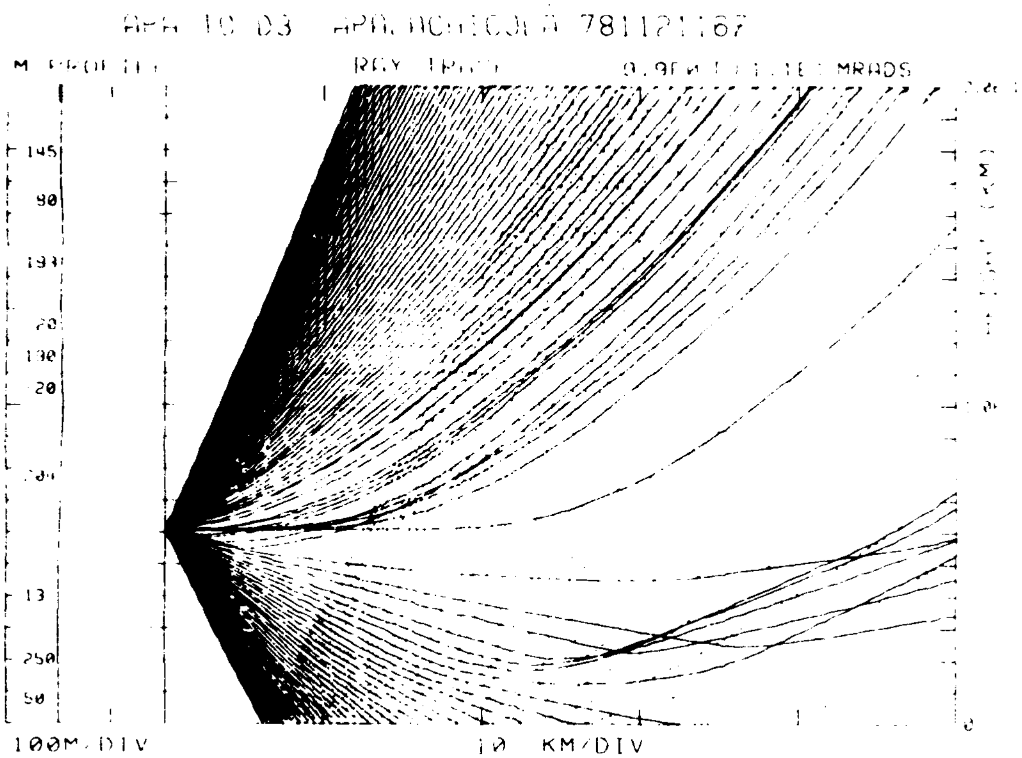


Figure 11-56. Case 11 Raytrace, APA to D3, Apalachicola 21 Nov 78, 1600Z, Transmitter Height 61.0 m.

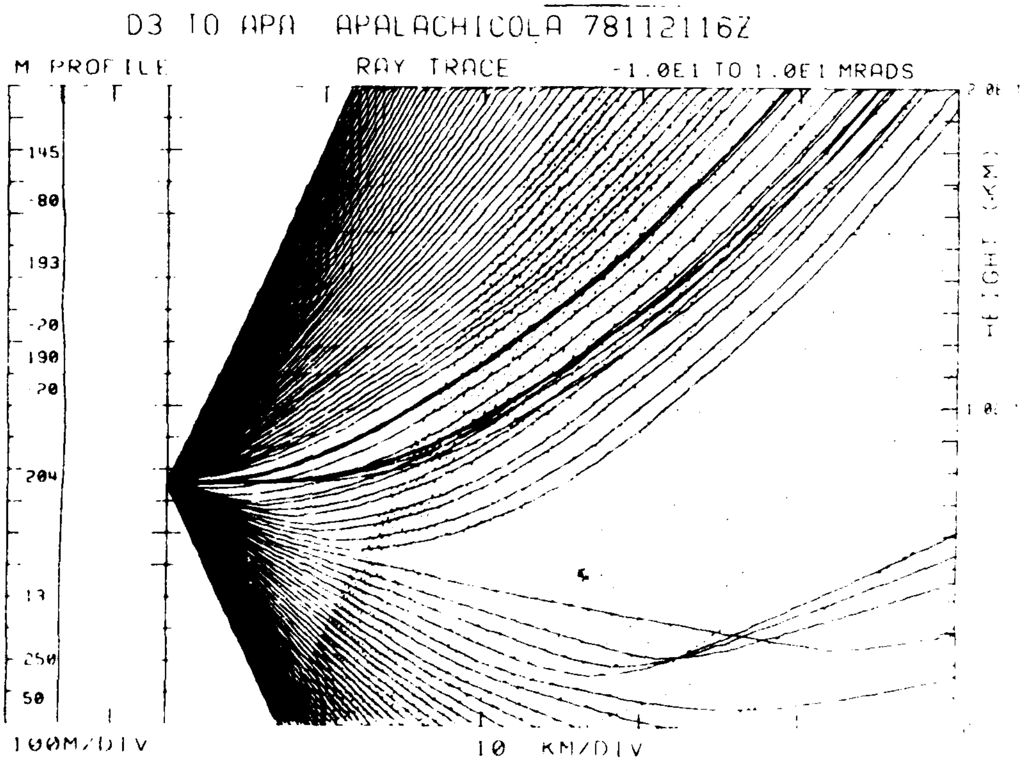


Figure 11-57. Case 11 Raytrace, D3 to APA, Apalachicola 21 Nov 78, 1600Z, Transmitter Height 76.2 m.

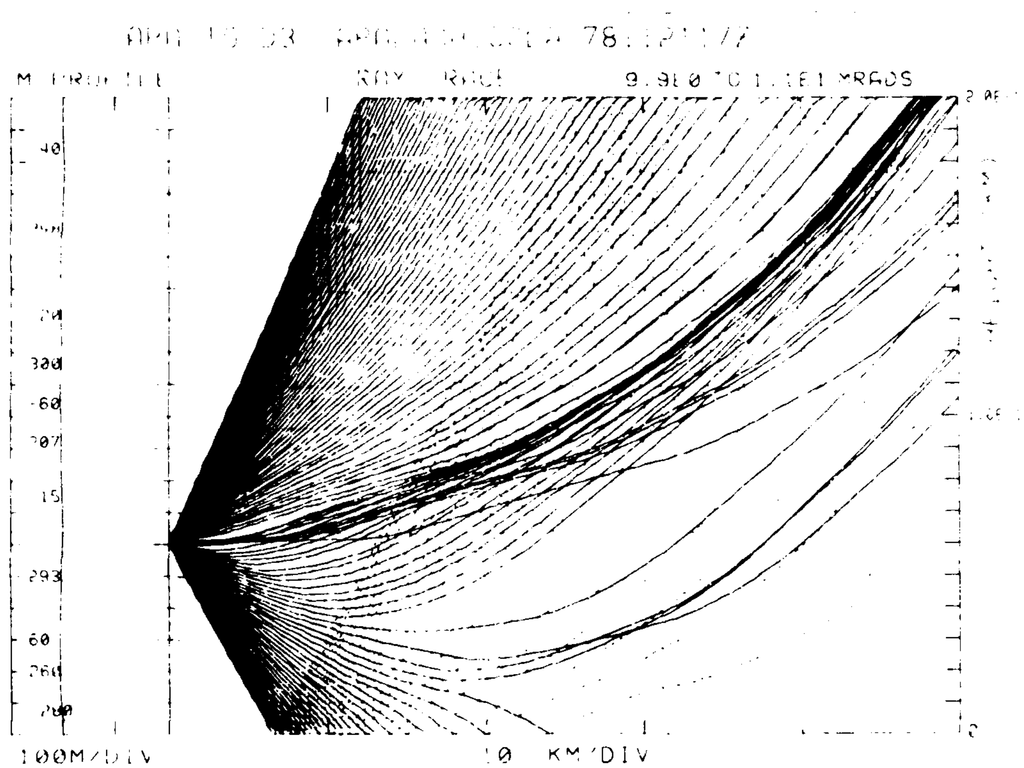


Figure 11-58. Case 11 Raytrace, APA to D3, Apalachicola 21 Nov 78, 1700Z, Transmitter Height 61.0 m.

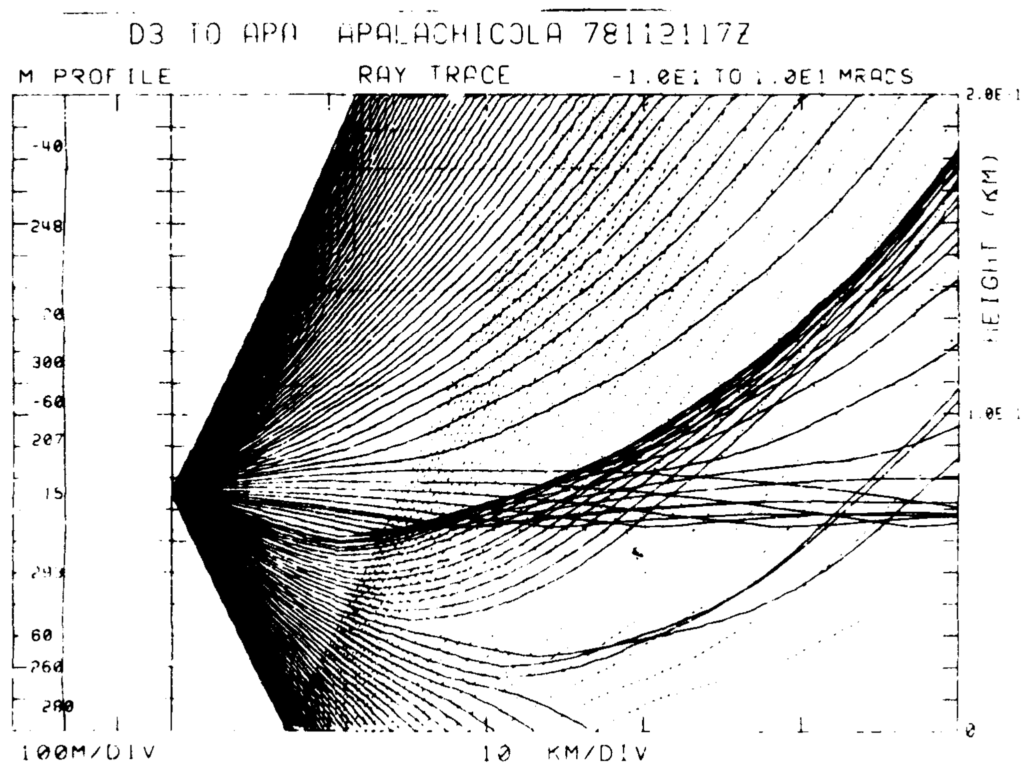


Figure 11-59. Case 11 Raytrace, D3 to APA, Apalachicola 21 Nov 78, 1700Z, Transmitter Height 76.2 m.

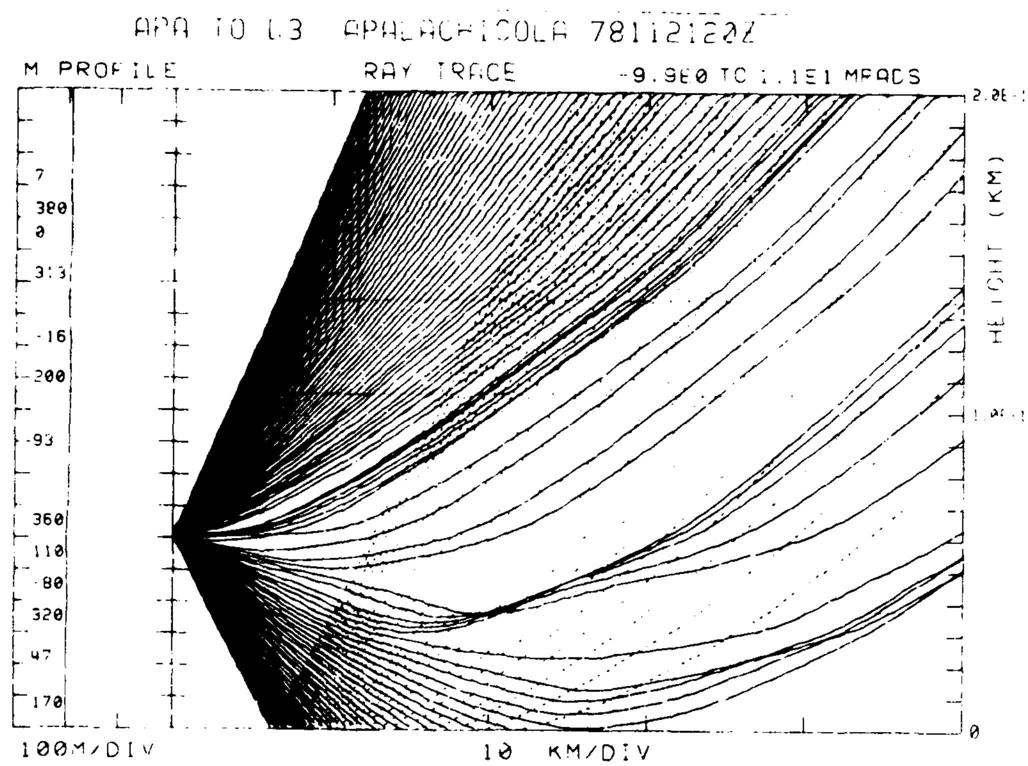


Figure 11-60. Case 11 Raytrace, APA to D3, Apalachicola 21 Nov 78, 2000Z, Transmitter Height 61.0 m.

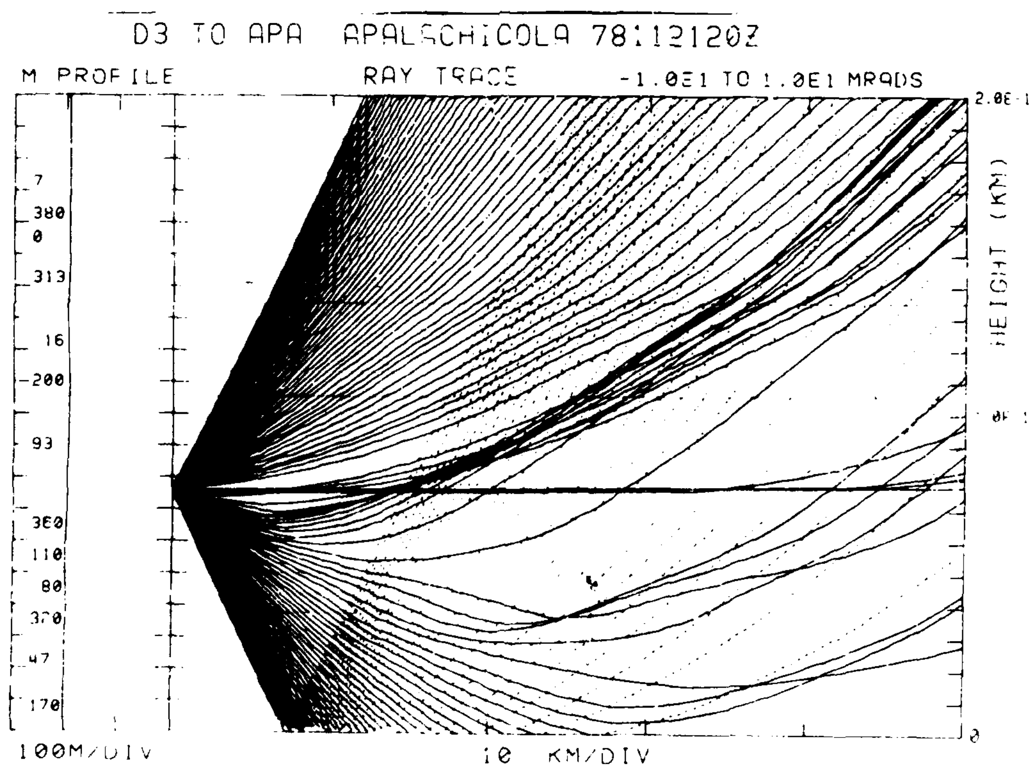


Figure 11-61. Case 11 Raytrace, D3 to APA, Apalachicola 21 Nov 78, 2000Z, Transmitter Height 76.2 m.

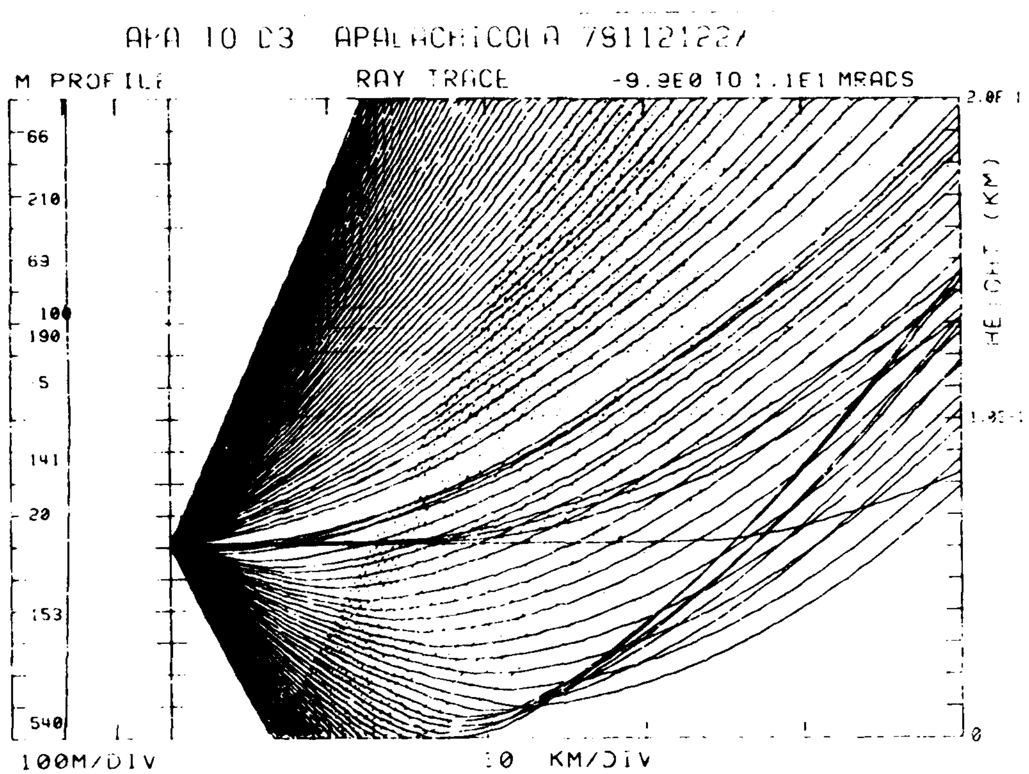


Figure 11-62. Case 11 Raytrace, APA to D3, Apalachicola 21 Nov 78, 2200Z, Transmitter Height 61.0 m.

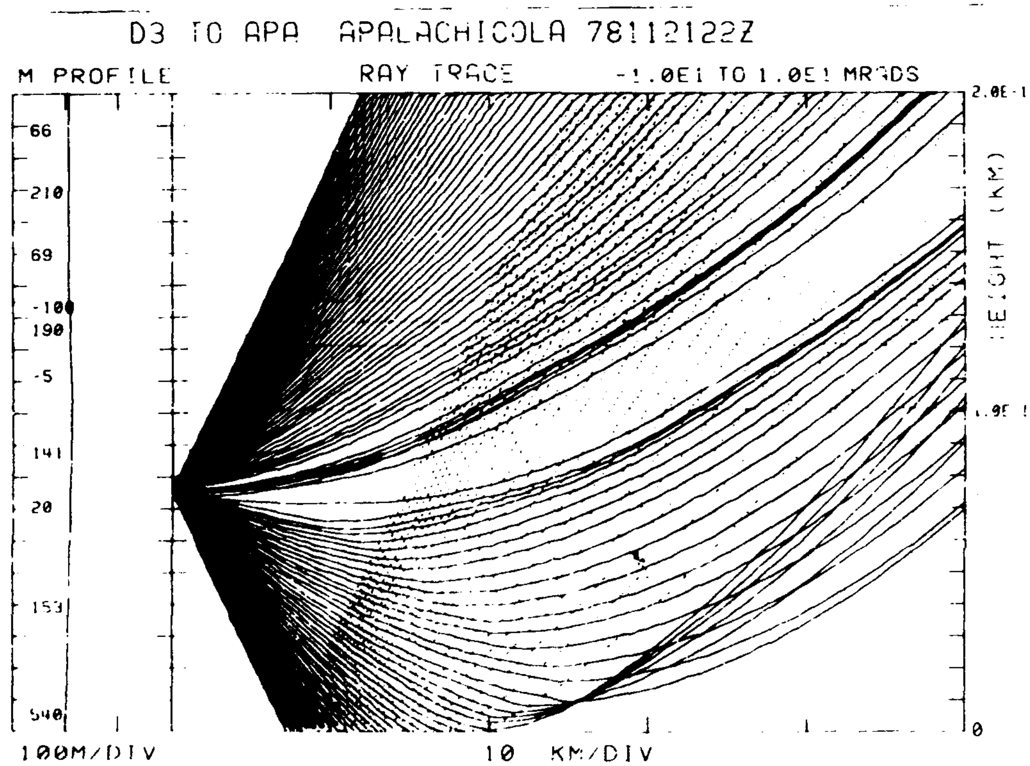


Figure 11-63. Case 11 Raytrace, D3 to APA, Apalachicola 21 Nov 78, 2200Z, Transmitter Height 76.2 m.

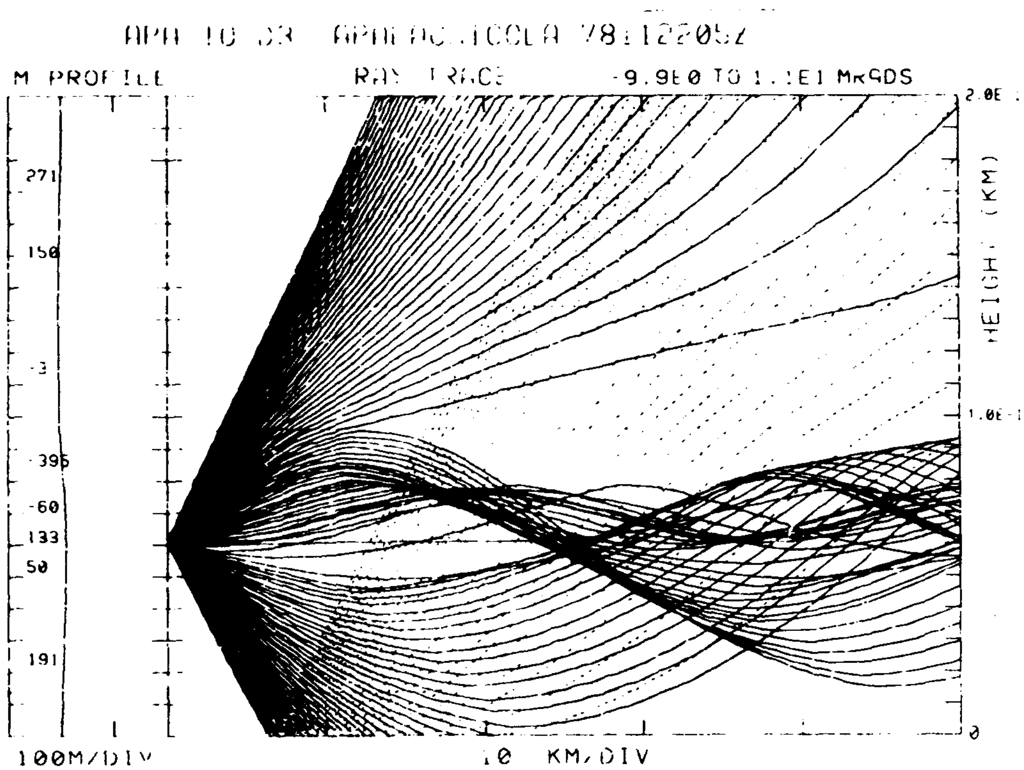


Figure 11-64. Case 11 Raytrace, APA to D3, Apalachicola 22 Nov 78, 0500Z, Transmitter Height 61.0 m.

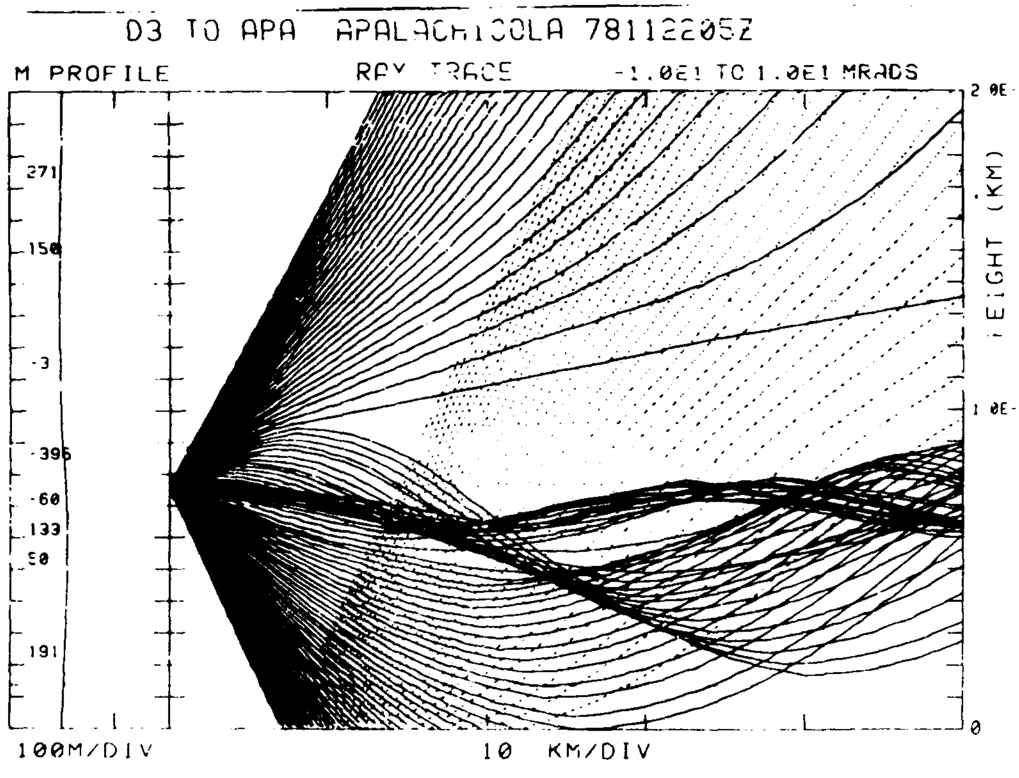


Figure 11-65. Case 11 Raytrace, D3 to APA, Apalachicola 22 Nov 78, 0500Z, Transmitter Height 76.2 m.

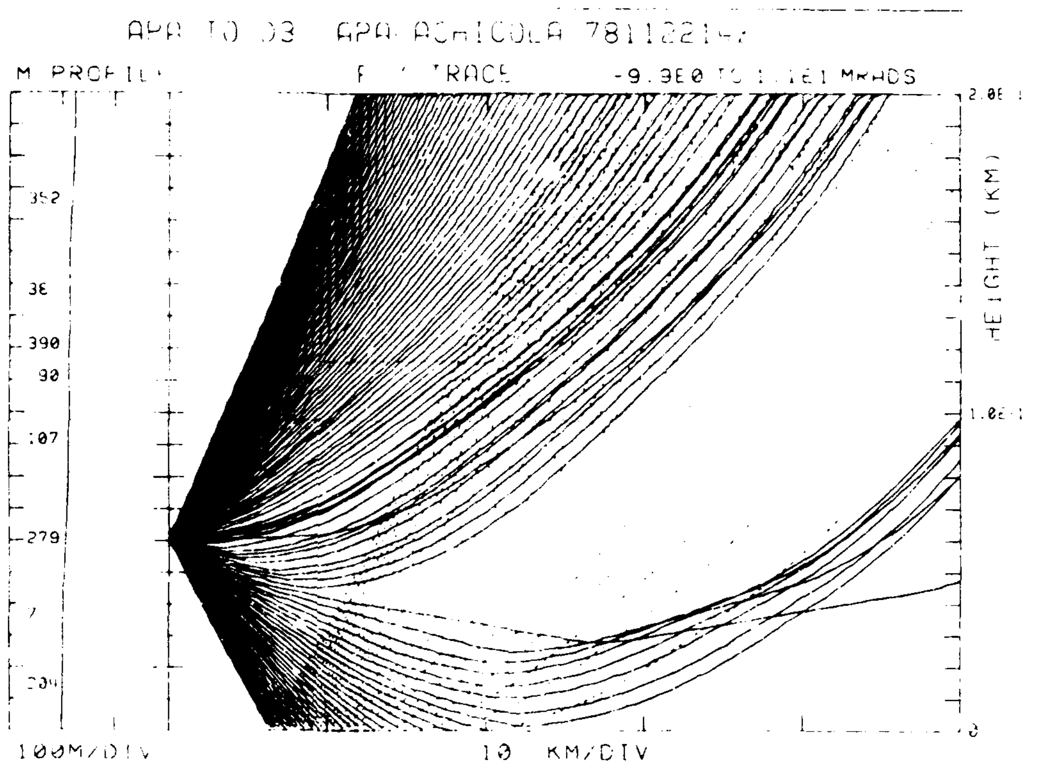


Figure 11-66. Case 11 Raytrace, APA to D3, Apalachicola 22 Nov 78, 1400Z, Transmitter Height 61.0 m.

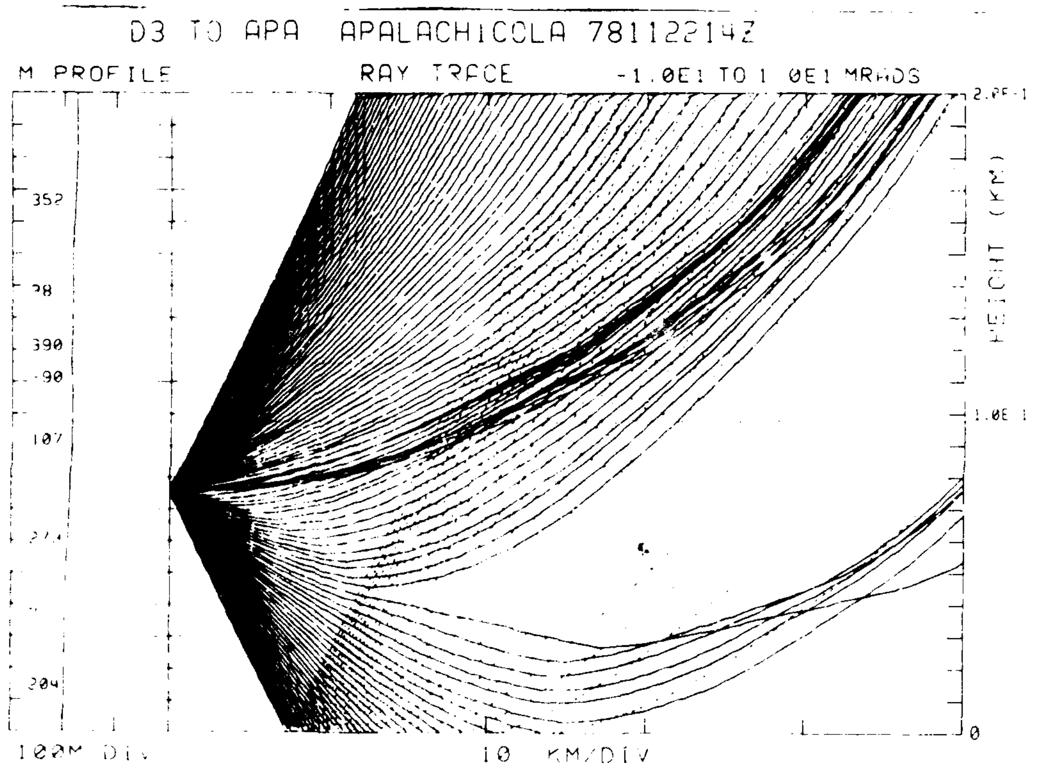


Figure 11-67. Case 11 Raytrace, D3 to APA, Apalachicola 22 Nov 78, 1400Z, Transmitter Height 76.2 m.

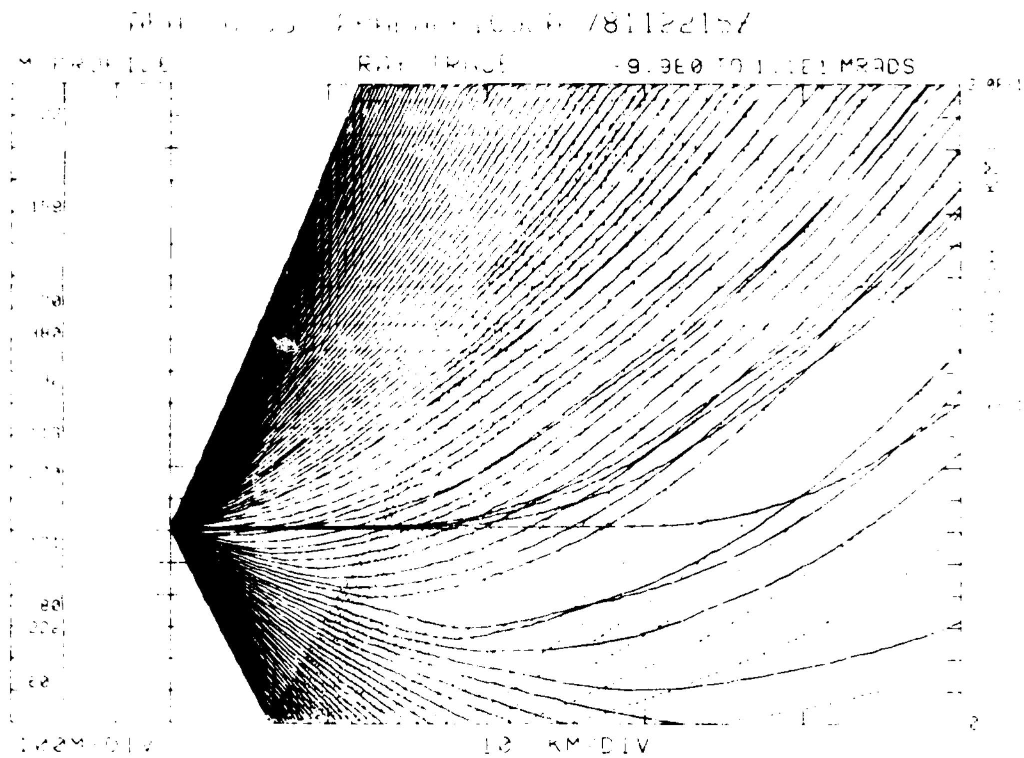


Figure 11-68. Case 11 Raytrace, APA to D3, Apalachicola 22 Nov 78, 1500Z, Transmitter Height 61.0 m.

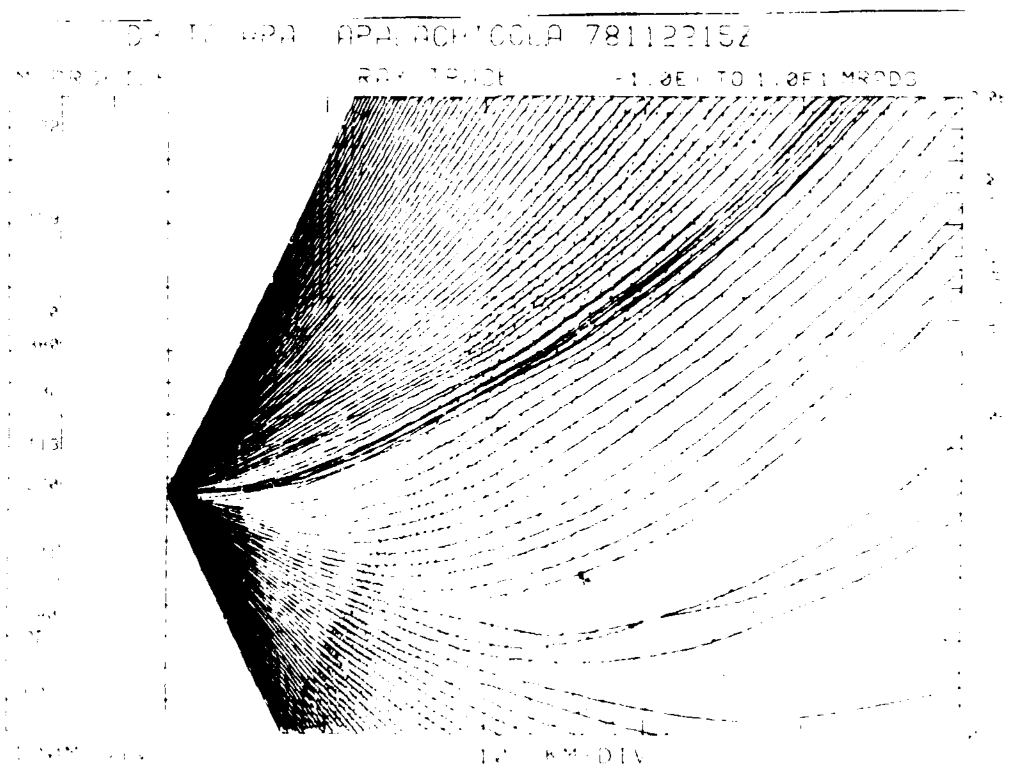


Figure 11-69. Case 11 Raytrace, D3 to APA, Apalachicola 22 Nov 78, 1500Z, Transmitter Height 76.2 m.

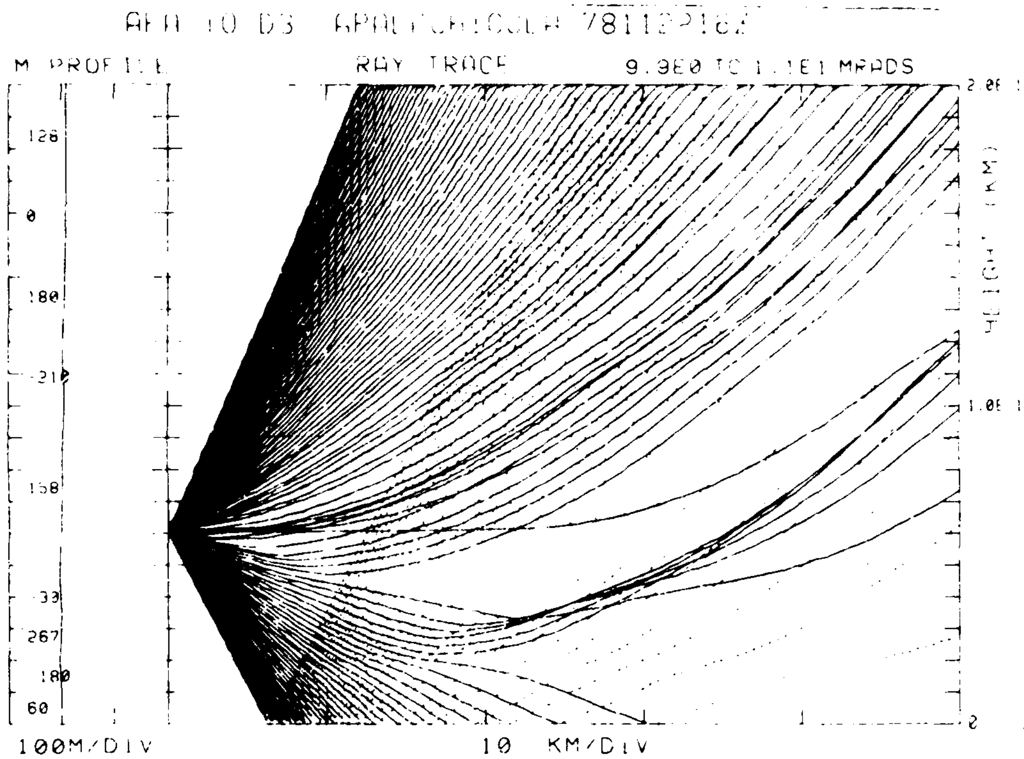


Figure 11-70. Case 11 Raytrace, APA to D3, Apalachicola 22 Nov 78, 1600Z, Transmitter Height 61.0 m.

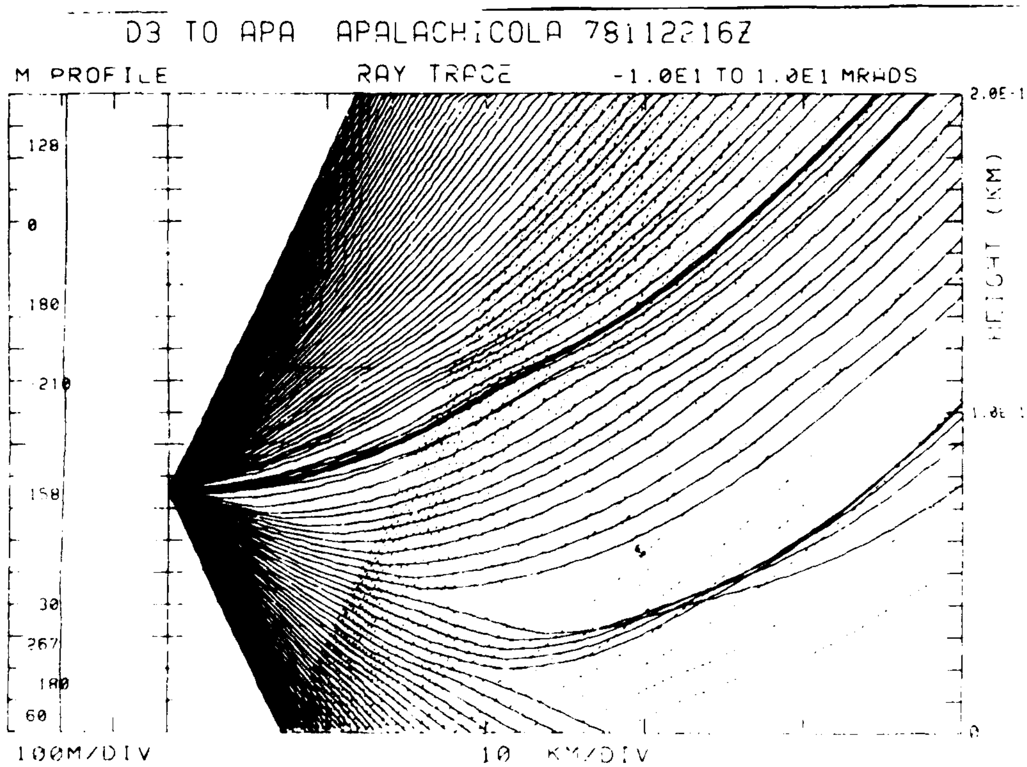


Figure 11-71. Case 11 Raytrace. D3 to APA, Apalachicola 22 Nov 78, 1600Z, Transmitter Height 76.2 m.

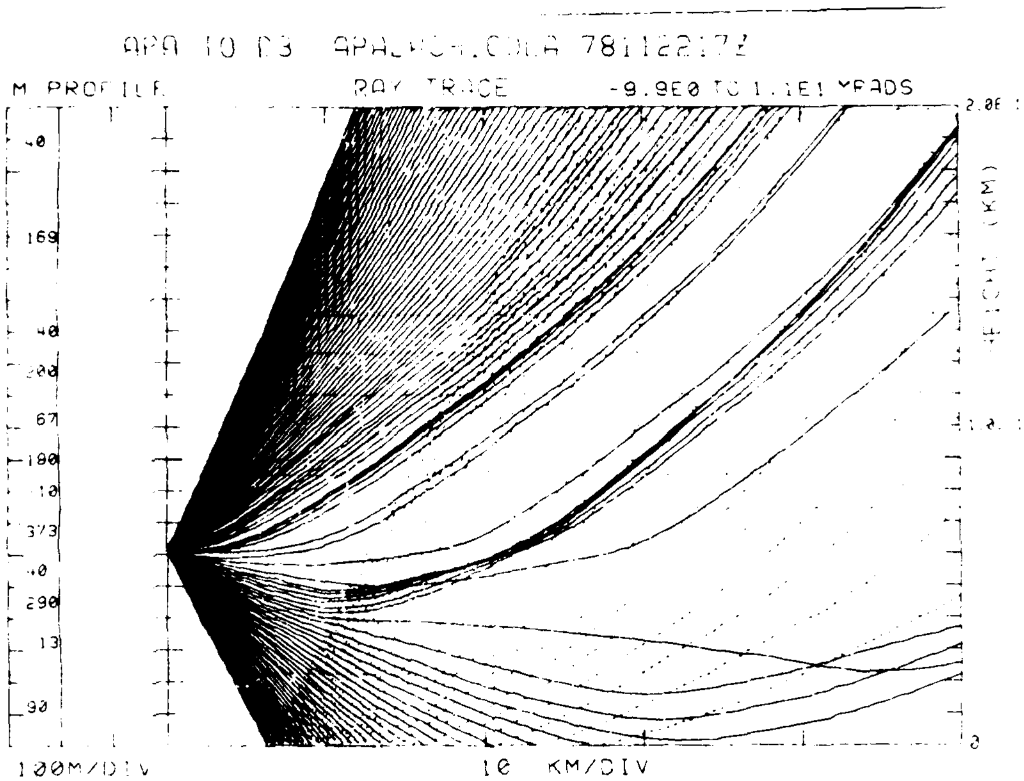


Figure 11-72. Case 11 Raytrace, APA to D3, Apalachicola 22 Nov 78, 1700Z, Transmitter Height 61.0 m.

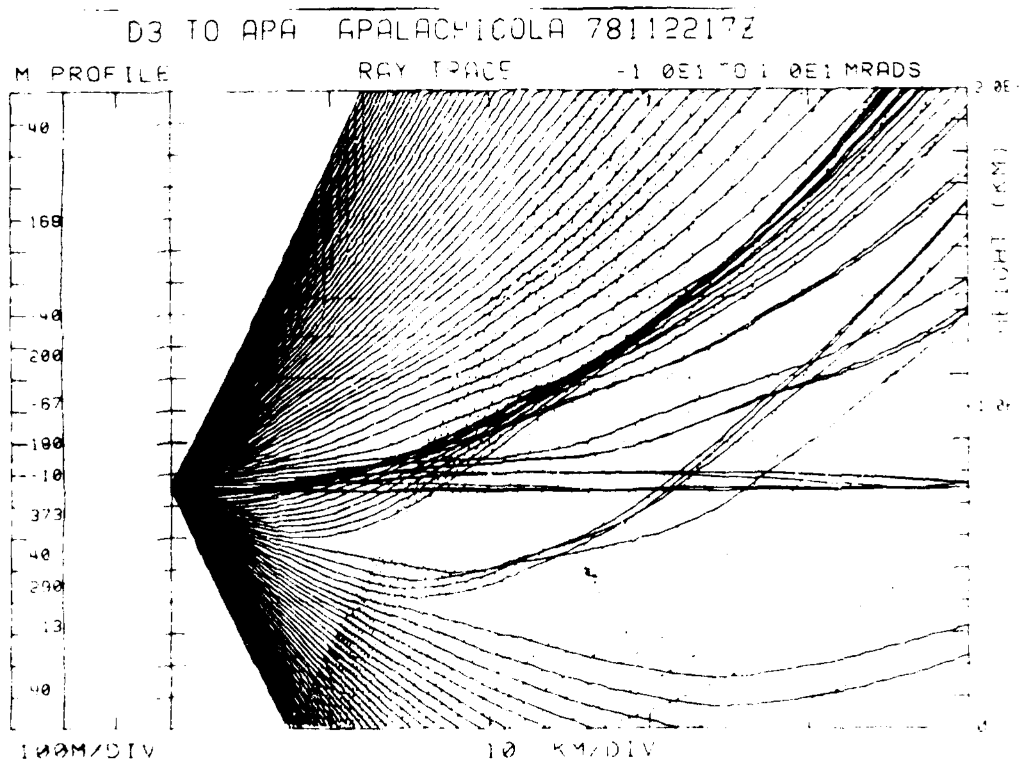


Figure 11-73. Case 11 Raytrace, D3 to APA, Apalachicola 22 Nov 78, 1700Z, Transmitter Height 76.2 m.

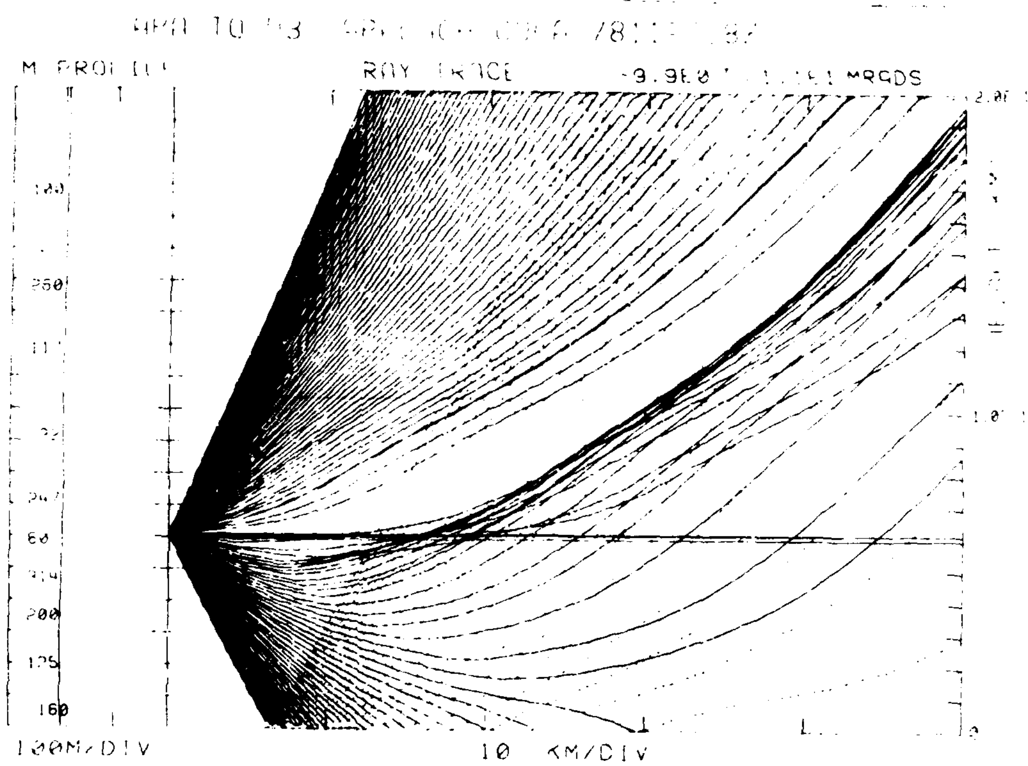


Figure 11-74. Case 11 Raytrace, APA to D3, Apalachicola 22 Nov 78, 1800Z, Transmitter Height 61.0 m.

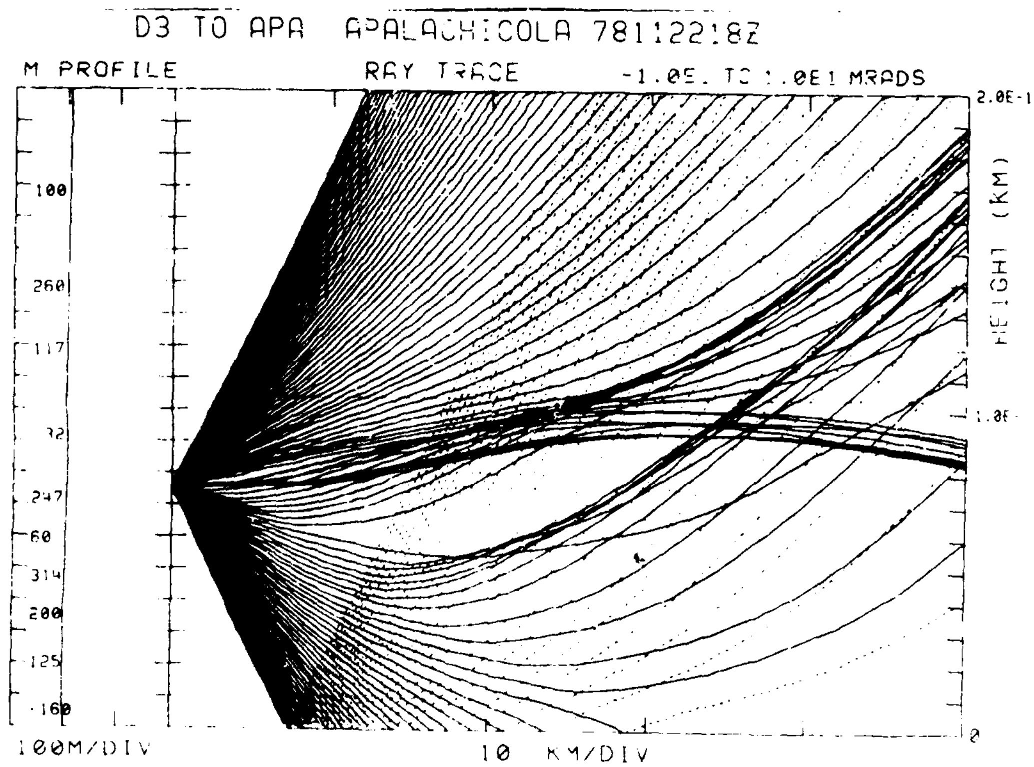


Figure 11-75. Case 11 Raytrace, D3 to APA, Apalachicola 22 Nov 78, 1800Z, Transmitter Height 76.2 m.

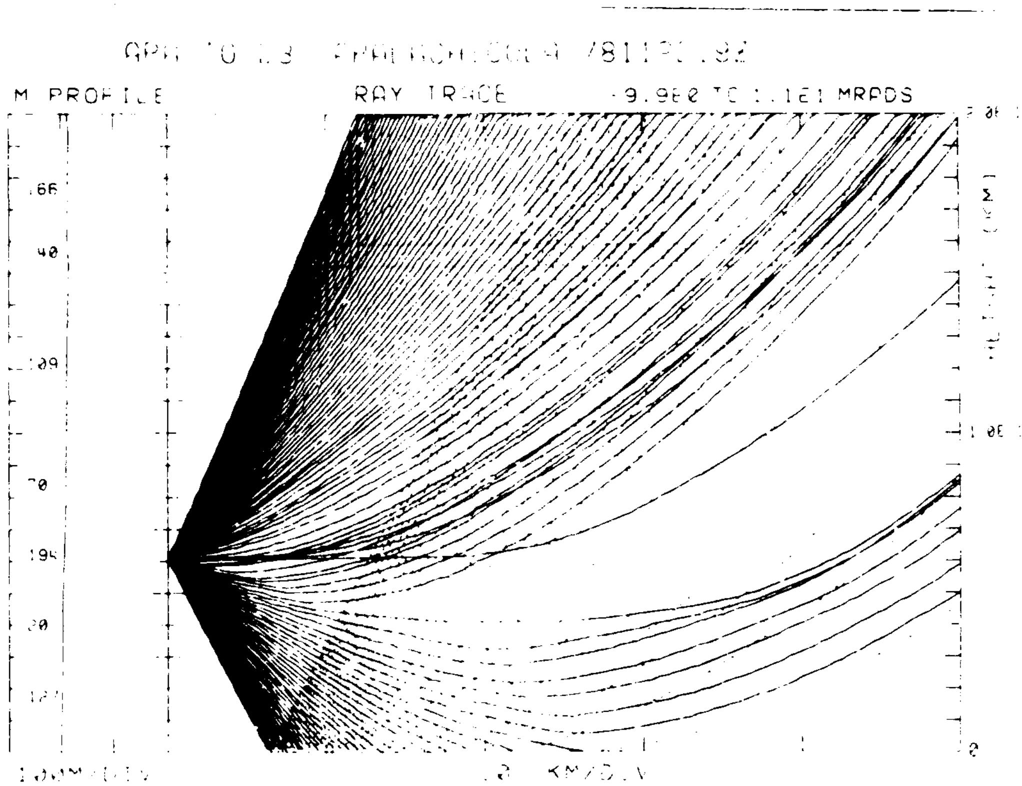


Figure 11-76. Case 11 Raytrace, APA to D3, Apalachicola 22 Nov 78, 1900Z, Transmitter Height 61.0 m.

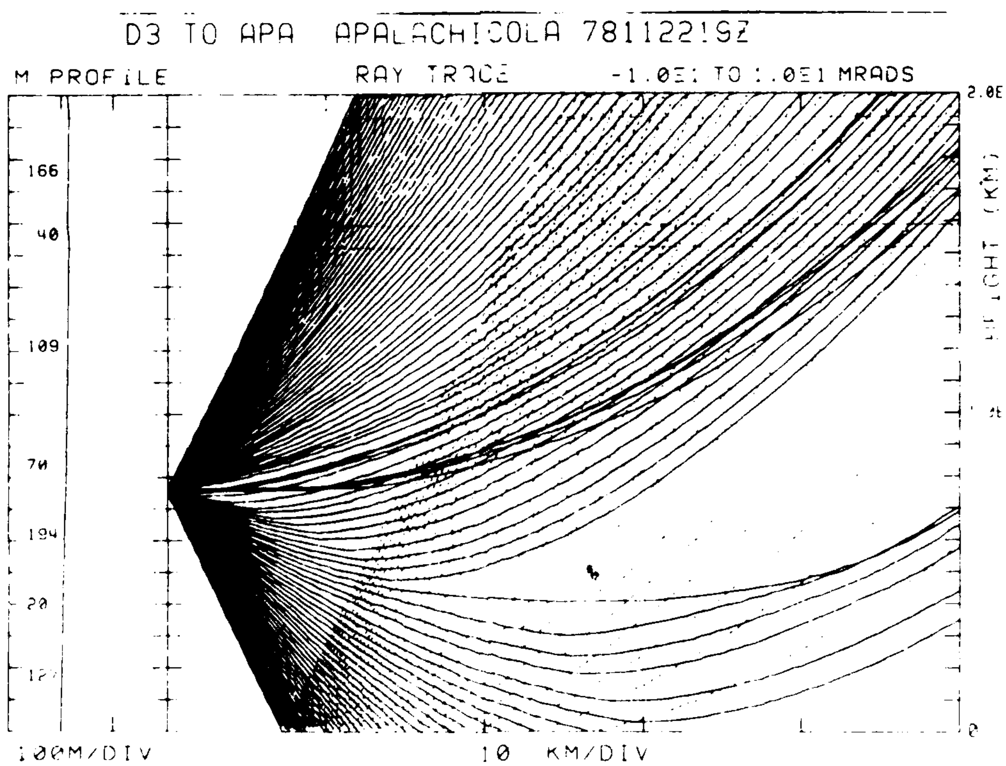


Figure 11-77. Case 11 Raytrace, D3 to APA, Apalachicola 22 Nov 78, 1900Z, Transmitter Height 76.2 m.

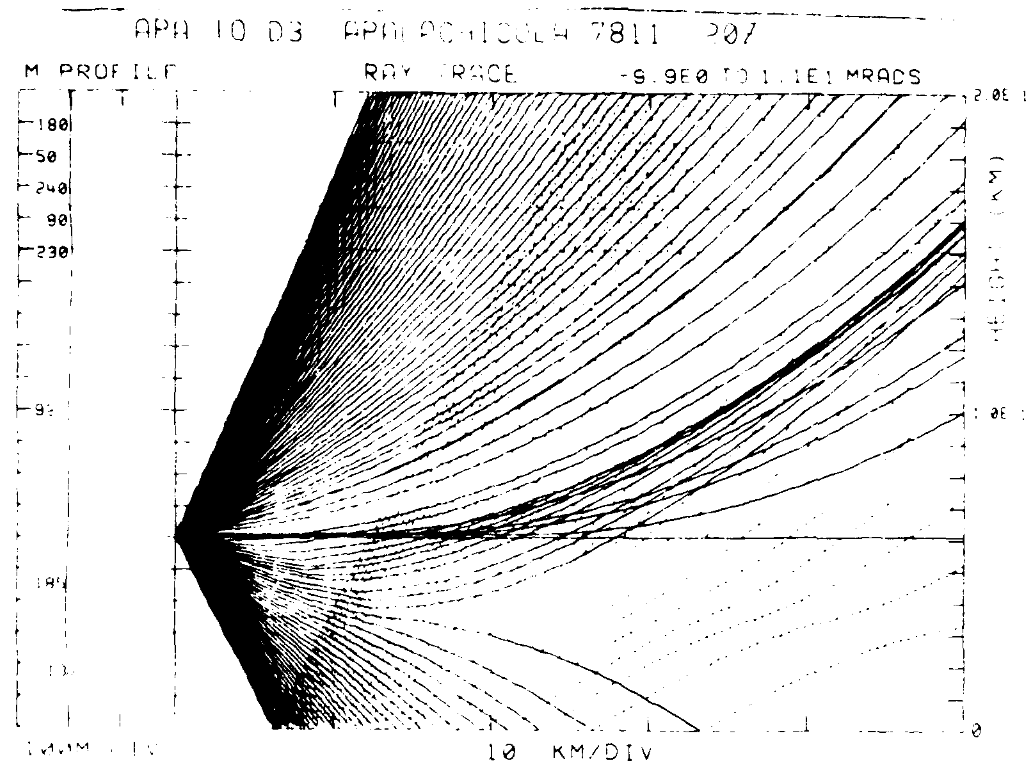


Figure 11-78. Case 11 Raytrace, APA to D3, Apalachicola 22 Nov 78, 2000Z, Transmitter Height 61.0 m.

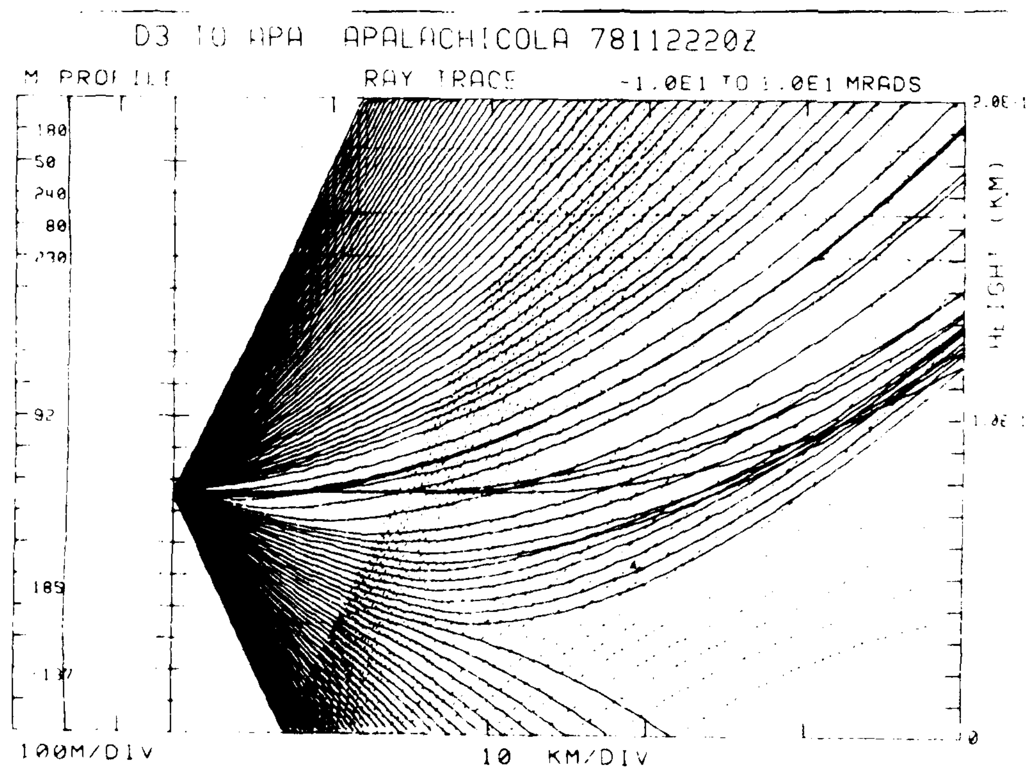


Figure 11-79. Case 11 Raytrace, D3 to APA; Apalachicola 22 Nov 78, 2000Z, Transmitter Height 76.2 m.

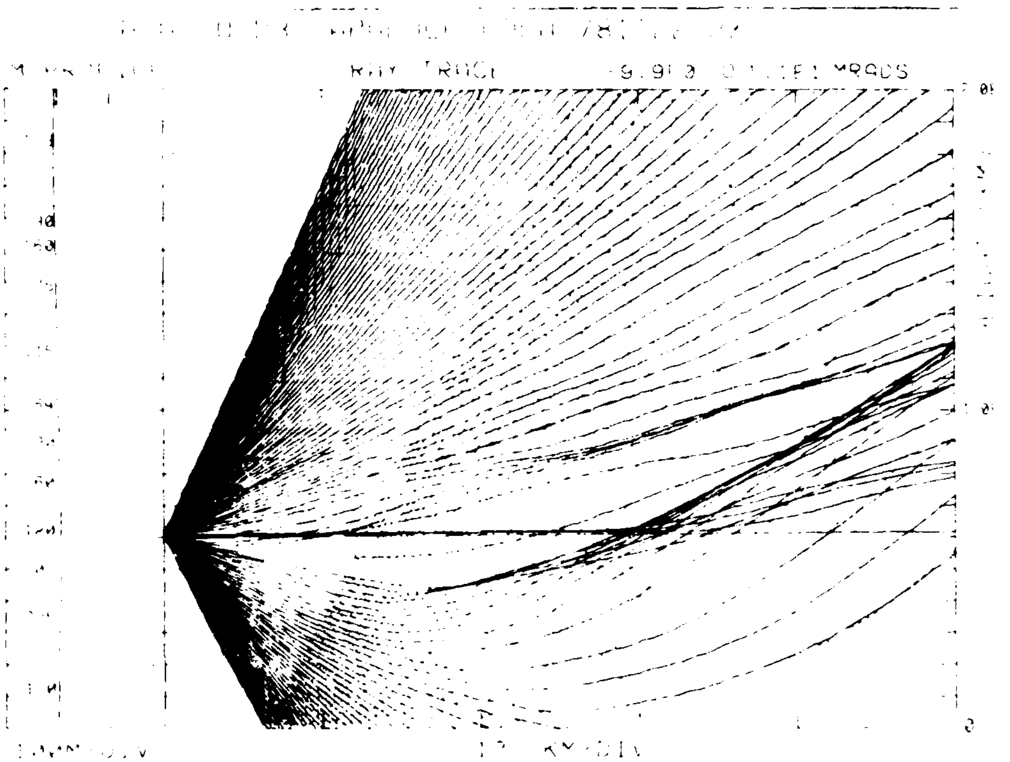


Figure 11-80. Case 11 Raytrace, APA to D3, Apalachicola 22 Nov 78, 2200Z, Transmitter Height 61.0 m.

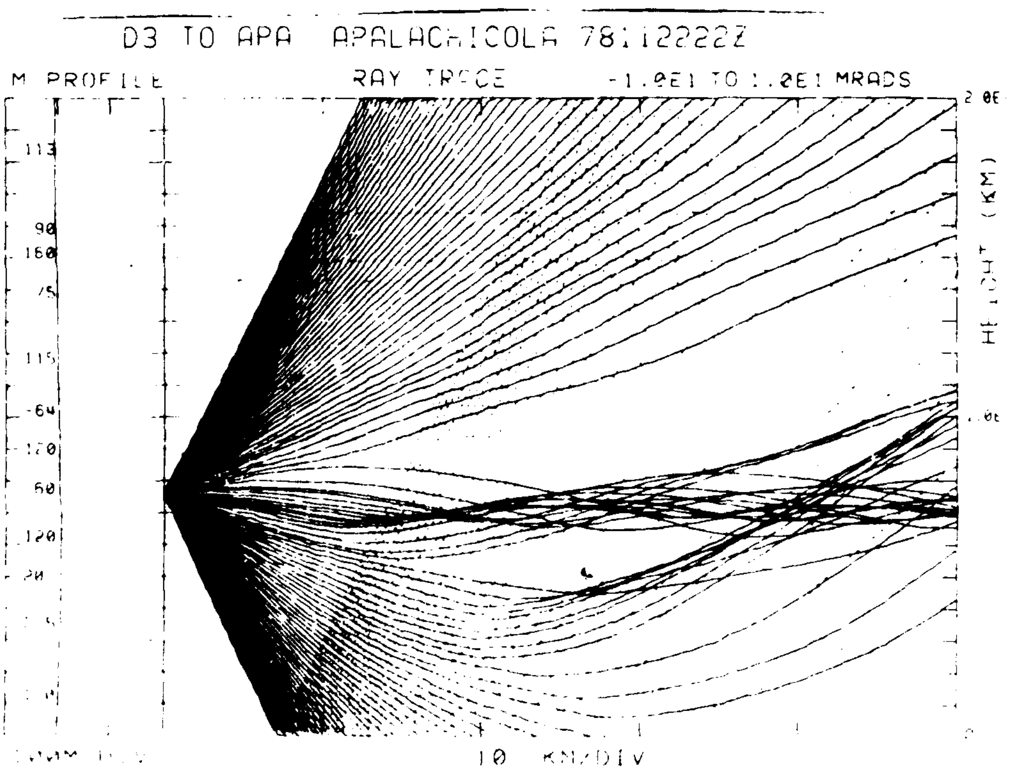


Figure 11-81. Case 11 Raytrace, D3 to APA, Apalachicola 22 Nov 78, 2200Z, Transmitter Height 76.2 m.

CONCLUSIONS

1. The primary purpose for this report was to provide 1842 EEG engineers with a meteorological basis upon which to upgrade the Tyndall microwave link, such upgrade to result in 99.9999% ("six nine") reliability, or a maximum acceptable outage per year of 32 seconds. Unfortunately, project limitations described in the introduction restricted providing meteorological information that would even approach such demanding reliability. This report could only assist in determining methods for improving conditions of the microwave link as it existed during the test period. The study made apparent, however, several interesting relationships between the environment and microwave propagation along the Florida link.

2. Examination of the RSL charts presented in each of the cases suggests that:

a. No extended blackouts or power fades occurred.

b. The type of fades observed on the D1C-D3 path generally differ from those in the D3-APA path (especially in Case 3) in that a rolling RSL fluctuation was generally observed with the latter and a combined rolling and painting RSL fluctuation was observed with the former.

c. Based on discussions with the 1842EEG, multipath propagation was prevalent in both paths. It's interesting to note that the duration (about 15-20 minutes) of most rolling patterns equates to the duration of a Kelvin-Helmholtz gravity wave's passage over a point. Such waves are routinely detected by either vertically painting acoustic sounders or vertically painting FM-CW radars. However, to state that intense refractive gradients associated with gravity waves are the primary cause of the rolling RSL fluctuations is purely speculative and cannot be supported by data collected for this project.

3. Examination of the synoptic weather maps reveals that:

a. "Bad" cases (1-7) were associated with weak surface winds (usually northeasterly), no precipitation, clear or scattered cloud sky conditions, and fog or haze during the early-morning hours.

b. "Good" cases (8-11) were associated, at times, with many of the features indicated with bad cases, except that a frontal system passed over the area in Cases 9-11 and precipitation was more prevalent.

4. The fronts and precipitation in Cases 9-11 suggest that the degree of subsiding air over the area was significantly diminished from that associated with the "bad" cases. Indeed, an examination of temperature and dew-point profiles for NWS Apalachicola 00Z and 12Z upper-air soundings (not shown in the report) indicates relatively strong subsidence and surface inversions associated with "bad" cases and a general lack thereof for "good" cases. Since subsidence routinely causes temperature inversions near the surface that can lead to poor RSL conditions, it becomes suspect as a prime cause of fades. An examination of the quantifiable vertical velocities of synoptic air over the region was intended for inclusion in the final report.

5. The surface weather observations at Apalachicola, Tyndall, and Eglin show a strong bias toward light northeasterly, or calm, winds during "bad-case" periods. Winds during "good" cases showed more variability in both wind direction and speed. Also, a sea breeze developed near the end of several of the "bad-case" periods.

6. All the "bad-case" periods showed a strong preference for beginning at night and ending during early to late morning, especially at a time near sunrise. However, some other "bad" cases that were not examined in this report occurred at other times. Furthermore, RSL recordings were not continuous throughout the period.

7. The M-profiles generally showed three different temporal and spatial scales of phenomena: (1) the mean profile for the entire 300-meter vertical increment, (2) the strong ducts and subrefractive layers that showed some degree of temporal and spatial persistency, and (3) the numerous minor fluctuations that showed no persistency in time or

space, but were sometimes very intense over a small vertical increment. Trends in M-profiles were hard to detect, especially since the temporal and spatial samples of sounding data were nonuniform. However, many of the "bad-case" profiles showed a high degree of M-varibility through the first 100-150 meters, and a lower degree of variability above. Samples of Cape San Blas acoustic sounder data collected by the Coastal Studies Institute of Louisianna State University during part of the test period (samples not shown here) also displayed a strong thermal discontinuity at about 100-150 meters (especially at night).

8. Figure C-1 is a classic example of the variability of M expressed in terms of height versus M-gradients. In this case, the M-gradients were computed over each approximated 5-meter increment in the Cape San Blas 4 Nov/14Z sounding and normalized at M per 100 meters. Vertical lines were constructed in the figure to delineate the ranges of the standard categories or refraction (trapping, superrefraction, normal refraction, and subrefraction). Note the abrupt change in gradient variability at about 125 meters.

9. Figure C-2 shows temperature and relative humidity (RH) profiles from the Cape San Blas sounding used to produce Figure C-1. Note the rather sudden drop in RH between 100-125 meters. This is probably the largest direct contribution to the change in M-varibility, even though temperature increases rapidly above 100 meters. Figures C-1 and C-2 strongly imply that the use of mean M-gradients (or of any subsequently derived element such as the engineering K-factor) over say, the first 100 meters of the atmosphere from standard rawinsonde observations, may require further examination and possible revision. For example, it is possible to use existing engineering design schemes (which employ K-factors) to determine minimum path clearances and specify less than optimum antenna heights due to the many environmental influences on a microwave beam.

10. Given the observed synoptic patterns and the nature of the M-profiles, it is suspected that low-level thermal and moisture discontinuities along the Florida panhandle coastline become highly variable and enhanced in the boundary layer whenever the boundary layer is "decoupled" from the air above it (usually during periods when the area is under the influence of subsiding air in and around a relatively stagnant high-pressure region). Furthermore, the boundary layer height can expand upward during the summer months to well above 300 meters. Discussions with a coastal micrometeorology expert indicated that the atmosphere in the boundary layer near Tyndall AFB is highly complex and ever-changing during most of the year. For this reason, categorization of the boundary layer atmosphere for purposes of microwave link design is impractical, especially under the database and time restrictions for this project.

11. Examination of raytraces for all cases clearly indicates that much less beam pattern disruption occurs when the transmitting antenna is elevated to 158.4 meters MSL (500 feet AGL) and "looks down" toward a much lower receiving antenna. As mentioned in Case 1, this improvement should occur on the basis of theoretical geometry considerations in spite of the raytrace limitations. This improvement should be enhanced by shortening the path lengths and expanding link flexibility through space and frequency diversity.

12. The D1C-D3 path is mostly over water. This, coupled with the highly variable atmosphere in the region, suggests that multipath problems due to surface reflections probably could be decreased by avoiding an over-water path.

13. The climatological ducting frequency for this region (based on standard upper-air data from Eglin AFB) is high during the fall, spring, and early summer. Only in mid-winter is there a significant decrease in ducting frequency.

14. In summary, significant meteorological improvements in the microwave link, (as it existed during the test period) should occur from the actions listed below. The *degree* of improvement, unfortunately, cannot be quantified here.

a. Move to overland paths.

b. Shorten path lengths as much as possible.

c. Transmit from as high an antenna as possible to a relatively low antenna (provided proper masking or reflections can be achieved).

d. Adopt both frequency and space diversity techniques.

15. More explicit and comprehensive results might have been achieved in this project had more time and effort been available to plan the data-gathering process and analyze the data. Perhaps this is one of the most important conclusions drawn thus far.

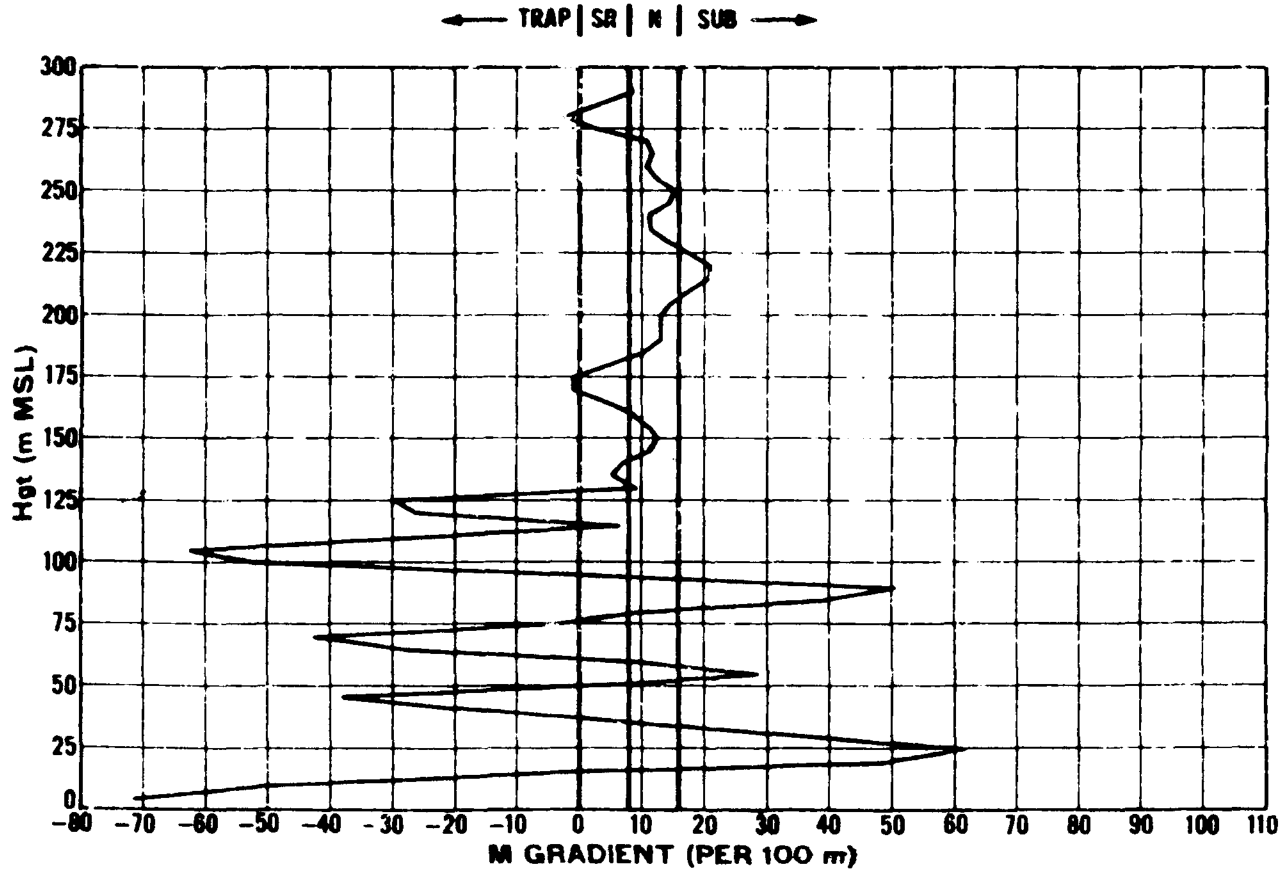


Figure C-1 M Gradient (per 100 m)

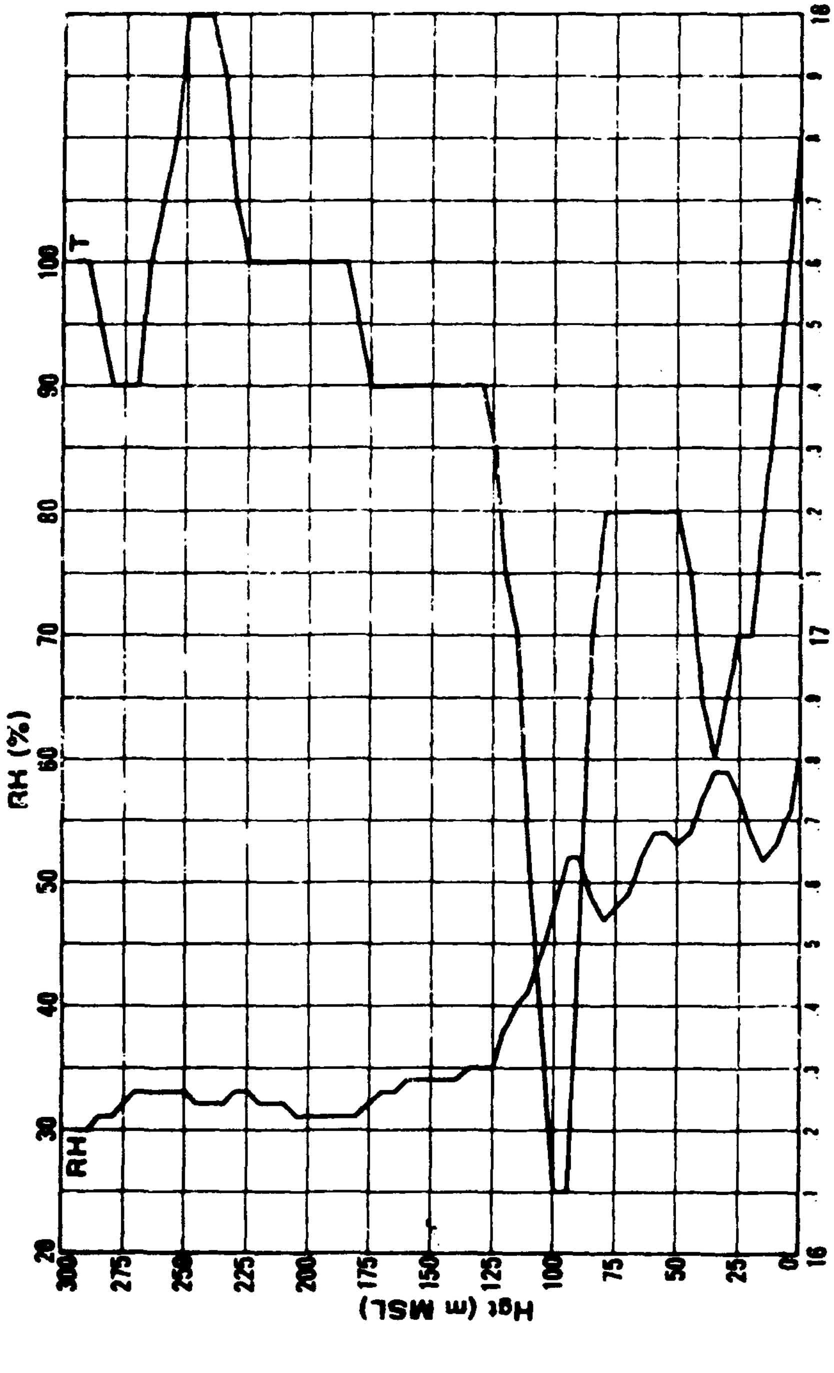


Figure C-2 T Degrees C

APPENDIX A

RAYTRACE PLOT DESCRIPTION

1. GENERAL: Each raytrace plot depicts a two-dimensional vertical slice of an assumed spherically homogeneous atmosphere and the associated pattern of propagating electromagnetic "rays" from a point-source transmitter.

2. DESCRIPTION:

a. Vertical height (Km) is scaled along the ordinate, and great-circle (Earth) range (Km) is scaled from left to right along the abscissa. There are always five equal divisions of range and 20 equal divisions of height, regardless of the total-height and total-range scales used. Since the curved Earth is depicted as a straight line, the ray curvature is adjusted appropriately upward (see Figures 1 and 2).

b. The transmitter height, the upper and lower bounds of transmitter "look" angles (milliradians), the angle increment (milliradians) between each transmitted ray, and the vertical and horizontal scales are set by the user.

c. A plotted vertical M-profile, where M is the modified atmospheric refractive index used when depicting the curved Earth surface (range) as a straight line is located on the left side of the raytrace plot. The M-profile is derived from a series of vertical M-gradients (numbers to the left of the M-Profile and expressed in M-units/Km) that are input into the raytrace program by the user and are calculated directly from a selected upper-air sounding or RAOB.

d. A terrain profile (depicting mountains, etc.) may be plotted by the user.

3. BASIC LIMITATIONS:

a. The upper-air sounding used (in reality only valid for the times and positions of data-measurement by the RAOB instrument as it traveled aloft) is applied uniformly throughout the slice of space depicted in the raytrace plot. This temporal and spatial variability must be considered carefully by the user before any operational decisions are made on the basis of a particular raytrace plot.

b. Azimuth angles and any possible bending of rays in other than a vertical plane are not taken into account.

4. DUCTING OF RAYS (See Figures 3 and 4): Ducting, or channeling of propagating energy into a relatively narrow atmospheric corridor that is assumed to be parallel with Earth's surface, is depicted in the plots by:

a. A negative M-gradient (M-profile that slopes to the left of vertical).

b. Straight, horizontal dotted lines that represent the top and bottom of an elevated duct and the top only of a ground-based duct.

c. An oscillating pattern of rays (approximately sinusiodal in appearance) that remain confined within the vertical bounds of the duct as described in 4b above. (Note: This may or may not be depicted on the plot, since it depends on the "look" angles of the transmitter relative to the duct, the severity of the duct, and the spatial density of the rays).

5. REFLECTED RAYS: All rays that are reflected from Earth's surface are depicted as dotted lines rather than continuous lines.

6. EARTH TERRAIN PROFILE: The user may specify for each plot either (1) flat terrain through the total range or (2) up to 200 points (range and height) that represent the relative variation of terrain elevation through the total range. The terrain profile normally is used to depict blocking of energy or energy "shadow zones" behind large obstructions such as mountains. Relatively flat terrain or ocean surfaces normally do not require the use of a terrain profile. A terrain profile is depicted in a plot as a dashed line that connects all terrain points fed into the program.

7. CONVERSION FACTORS:

a. 1 Degree = 17.453 milliradians.

b. 1 Nautical Mile = 1.852 Kilometers.

c. 1 Statute Mile = 1.609 Kilometers.

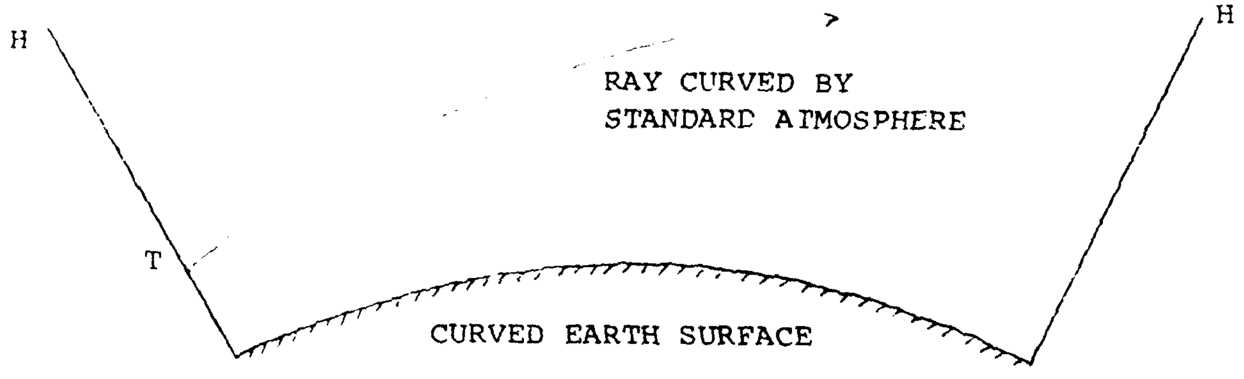


FIGURE 1. TRUE RAY GEOMETRY.

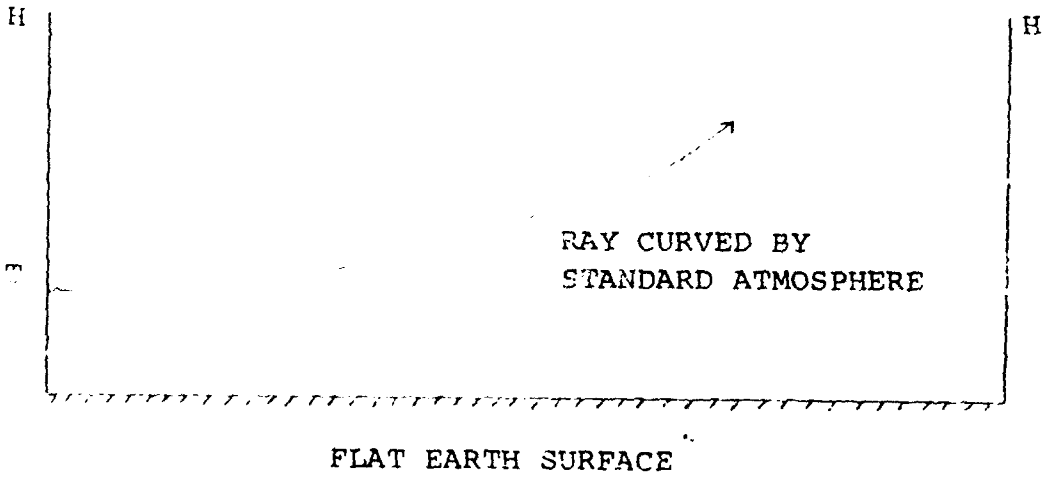


FIGURE 2. EQUIVALENT (ADJUSTED) RAY
GEOMETRY USED IN RAYTRACE.

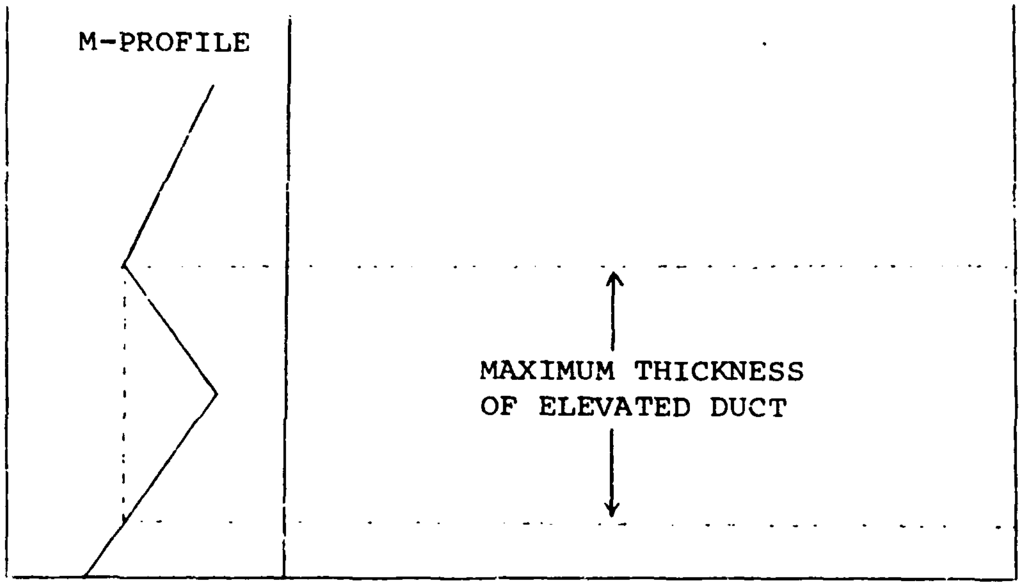


FIGURE 3. ELEVATED DUCT. Bottom of duct is determined by constructing a vertical line down from top of negative M-Profile to intersection with the M-Profile before the ground is reached.

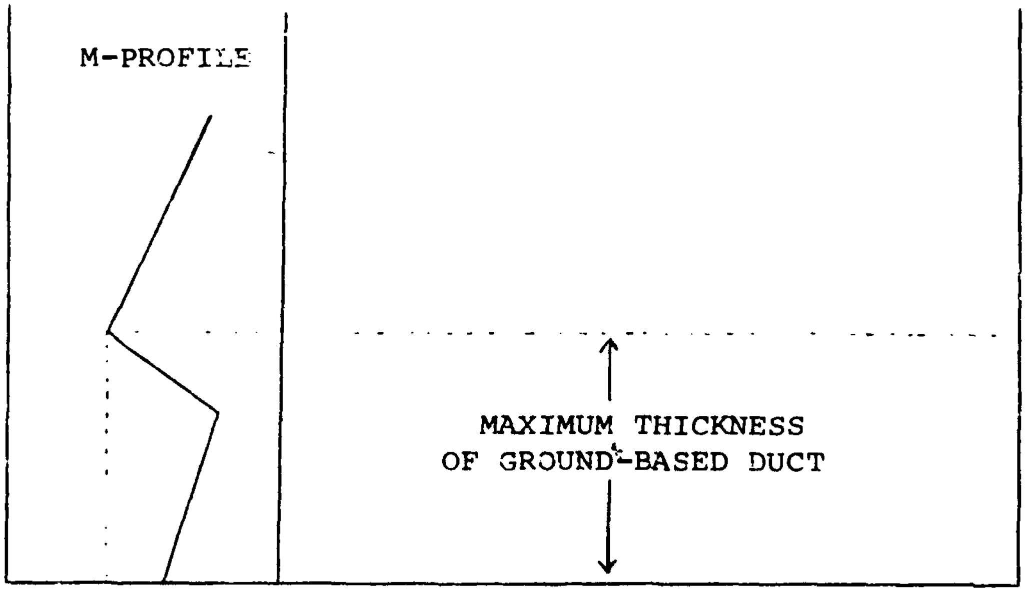


FIGURE 4. GROUND-BASED DUCT. Bottom of duct is determined the same way as in FIGURE 3 except vertical line reaches the ground before it can intersect the M-Profile.

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